ZERO WASTE ALLIANCE IRELAND

Towards Sustainable Resource Management

Feedback to the European Commission on a Proposed Directive on Soil Health – Protecting, Sustainably Managing and Restoring EU Soils

16 March 2022

Zero Waste Alliance Ireland is a member of

EEB European Environmental Bureau

and

IEN Irish Environmental Network

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1. INTRODUCTION

On 16 February 2022, the European Commission issued a call for evidence on which to base the proposed updating of the 2006 EU Soil Thematic Strategy[1] to address soil and land degradation in a comprehensive way and to fulfil EU and international commitments on land degradation, in accordance with the UN Sustainable Development Goal 15.3.

The call for evidence provided basic information to citizens and stakeholders about the Commission's planned initiative, and invited suggestions for a combination of voluntary and legislative action, with the intention of ensuring the full protection, sustainable use and restoration of soils, as described in the vision set out in the EU Soil Strategy for 2030, adopted in 2021, to have all of Europe's soils in healthy condition by 2050.[2]

The EU Soil Strategy for 2030 provides a vital background to the Commission's proposal to develop a comprehensive EU legal framework for soil protection and to grant this valuable natural resource the same level of protection as water and air. The reasons for providing such protection, are clear and self-evident, as stated in the Strategy:

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[1] Thematic Strategy for Soil Protection — Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. COM(2006)231 final. Brussels, 22.9.2006.

[2] EU Soil Strategy for 2030 — Reaping the benefits of healthy soils for people, food, nature and climate. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. COM(2021) 699 final. Brussels, 17.11.2021.

> *"Soil and the multitude of organisms that live in it provide us with food, biomass and fibres, raw materials, regulate the water, carbon and nutrient cycles and make life on land possible. It takes thousands of years to produce a few centimetres of this magic carpet.*
>
> *Soil hosts more than 25% of all biodiversity on the planet* [3] *and is the foundation of the food chains nourishing humanity and above ground biodiversity. This fragile layer will be expected to feed and filter drinking water fit for consumption to a global population of nearly 10 billion people by 2050.*
>
> *Healthy soils are also the largest terrestrial carbon pool on the planet. This feature, coupled with their sponge-like function to absorb water and reduce the risk of flooding and drought, makes soil an indispensable ally for climate change mitigation and adaptation.*[4] *Healthy soils therefore integrate part of the Union's climate, biodiversity and also long-term economic objectives".*

The need to protect European soils is so important that it has attracted the attention of the European Court of Auditors[5], and the European Environment Agency[6]; while a European Citizens' initiative "People4Soil" gathered the support of more than 500 organization from 26 EU countries, and collected over 220,000 signatures.[7]

The principal objectives of the European Citizens' initiative were to:

> *"Recognize soil as a shared heritage that needs EU level protection, as it provides essential benefits connected to human well-being and environmental resilience; develop a dedicated legally binding framework covering the main soil threats: erosion, sealing, organic matter decline, biodiversity loss and contamination; integrate soil related UN Sustainable*

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[3] FAO (2020). State of knowledge of soil biodiversity – Status, challenges and potentialities.

[4] Forging a climate-resilient Europe – the new EU Strategy on Adaptation to Climate Change. Commission Staff Working Document, Impact Assessment Report, accompanying the Communication from the Commission to the European Parliament, the Council, the Economic and Social Committee and the Committee of the Regions. SWD(2021) 25 final. Brussels, 24.2.2021.

[5] European Court of Auditors (2018), Special report number 33: Combating desertification in the EU: a growing threat in need of more action.

[6] The European environment — state and outlook 2020: Knowledge for transition to a sustainable Europe. European Environment Agency, 2019.

[7] Commission Staff Working Document accompanying the document "*EU Soil Strategy for 2030 — Reaping the benefits of healthy soils for people, food, nature and climate; Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions"*. SWD(2021) 323 final. Brussels, 17.11.2021.

Development Goals into EU policies; properly account and reduce greenhouse gases emissions from the farming and forestry sectors."

The current invitation to provide feedback on the proposed updating of the 2006 EU Soil Thematic Strategy gives a further opportunity to European citizens and stakeholders to give their views on the Commission's understanding of the problem of soil loss and soil degradation, and invites submissions on possible solutions, including how the very necessary high level of protection can be given to Europe's soils. Citizens and other stakeholders are also asked to share any relevant information that they may have, including information on possible impacts of the different options available to the Commission in support of the approach and actions that constitute the new EU Soil Strategy, and to expand the knowledge base contained in the Staff Working Document cited above (SWD(2021) 323 final).

The call for evidence issued on 16 February 2022 states that soils are the foundation for 95% of the food we eat, host more than 25% of the world's biodiversity, are the largest terrestrial carbon pool on the planet and play a key role in the circular economy and adaptation to climate change. They are also a finite and non-renewable natural resource. 60-70% of soil ecosystems in the EU are unhealthy and suffering from continuing degradation resulting in reduced provision of ecosystem services.

The call for evidence states that unhealthy soils can be:

i) ***In bad physical condition***:

- ✖ 12.7% of Europe is affected by moderate to high erosion;
- ✖ Between 2012 and 2018, more than 400 km² of land was taken per year in the EU for urban and artificial development on a net basis;
- ✖ More than 530 million tonnes of soil have been excavated and reported as waste; and,
- ✖ An estimated 30 to 50% of the most productive and fertile soils in Europe suffer from soil compaction.

ii) ***In bad chemical condition***:

- ✖ Europe currently exceeds its safe operating space for the nitrogen and phosphorous cycles by factors of 3.3 and 2.0 respectively.
- ✖ Diffuse and local soil contamination is widespread; 390,000 contaminated sites are expected to require remediation; yet, by 2018, only some 65,500 sites were remediated; and,
- ✖ Salinisation affects 3.8 million ha in the EU, with severe soil salinity along the coastlines, particularly in the Mediterranean.

iii) ***In bad biological condition***:

- ✖ Peatland drainage across all land categories in the EU emits around 5% of total EU greenhouse gas emissions; every year mineral soils under cropland are losing around 7.4 million tonnes of carbon.
- ✖ In recent decades, soil biodiversity such as the species richness of earthworms, springtails and mites has been reduced; and,
- ✖ The risk of desertification is increasing across the EU and already affecting agricultural production.

The principal **causes of soil degradation** in the EU are listed as:

- land-use change;
- urban sprawl, excessive and uncompensated spatial development and construction;
- climate change, drought, extreme weather;
- unsustainable soil management and intensification of agricultural and forestry practices;
- industrial activities and emissions, unsustainable waste management and energy production, accidents and spills;
- improper water management, reuse and irrigation; and,
- overexploitation, unmitigated and uncompensated consumption of natural resources.

Zero Waste Alliance Ireland (ZWAI) is very pleased to have the opportunity to provide feedback to the European Commission on this important topic, and we have undertaken some research to provide the Commission with reasonably detailed and evidence-based comments on the proposed Directive. We trust that the observations in this submission will be considered as a relevant and a positive contribution to EU strategies and measures for the improvement of soil health and for the sustainable use and restoration of soils.

2. ZERO WASTE ALLIANCE IRELAND (ZWAI)

At this point we consider that it is appropriate to mention the background to our submission, especially the policy and strategy of ZWAI.

2.1 Origin and Activities of ZWAI

Zero Waste Alliance Ireland (ZWAI), established in May 1999, and registered as a company limited by guarantee in 2004, is a Non-Government Environmental Organisation (eNGO) and a registered charity. During more than two decades ZWAI has submitted to the Government and to State Agencies many policy documents on waste management, on using resources sustainably, on promoting re-use, repair and recycling, and on development and implementation of the Circular Economy.

One of our basic guiding principles is that human societies must behave like natural ecosystems, living within the sustainable flow of energy from the sun and plants, producing no materials or objects which cannot be recycled back into the earth's systems, or reused or recycled into our technical systems, and should be guided by economic systems and practices which are in harmony with personal and ecological values.

Our principal objectives are:

i) sharing information, ideas and contacts,

ii) finding and recommending environmentally sustainable and practical solutions for domestic, municipal, industrial and agricultural waste management, and for more efficient and ecologically appropriate uses of natural resources such as water and soil;

iii) lobbying Government and local authorities to implement environmentally sustainable waste management practices, including clean production, elimination of toxic substances from products, re-use, recycling, segregation of discarded materials at source, and other beneficial practices;

iv) lobbying Government to follow the best international practice and EU recommendations by introducing fiscal and economic measures designed to penalise the manufacturers of products which cannot be re-used, recycled or composted at the end of their useful lives, and to financially support companies making products which can be re-used, recycled or are made from recycled materials;

v) raising public awareness about the long-term damaging human and animal health and economic consequences of landfilling and of the destruction of potentially recyclable or re-usable materials by incineration;

vi) investigating, raising public awareness and lobbying Irish Government departments and agencies about our country's failure to take adequate care of vulnerable and essential natural resources, including clean water and air, biodiversity, and soil;

vii) advocating changes in domestic and EU legislation to provide for more ecologically appropriate, environmentally sustainable and efficient uses of natural resources; and,

viii) maintaining contact and exchanging information with similar national networks in other countries, and with international zero waste organisations.

2.2 Our Basic Principles

In nature, the waste products of every living organism serve as raw materials to be transformed by other living creatures, or benefit the planet in other ways. Instead of organising systems that efficiently dispose of or recycle our waste, we need to design systems of production that have little or no waste to begin with.

There are no technical barriers to achieving a "zero waste society", only our habits, our greed as a society, and the current economic structures and policies which have led to the present environmental, social and economic difficulties.

"Zero Waste" is a realistic whole-system approach to addressing the problem of society's unsustainable resource flows – it encompasses waste elimination at source through product design and producer responsibility, together with waste reduction strategies further down the supply chain, such as cleaner production, product repairing, dismantling, recycling, re-use and composting.

ZWAI strongly believes that Ireland and other Member States, and the EU as a whole, should have a policy of not sending to other countries our discarded materials for further treatment or recycling, particularly to developing countries where local populations are being exposed to dioxins and other very toxic POPs. Relying on other countries' infrastructure to achieve our "recycling" targets is not acceptable from a global ecological and societal perspective.

ZWAI also strongly believes that soil and its associated biodiversity (surface and sub-surface living organisms) are vitally important components of the Earth's global ecosystem, and that the destruction or unnecessary wasting of these natural resources must not be allowed to continue.

2.3 What We are Doing

Our principal objective is to ensure that government agencies, local authorities and other organisations will develop and implement environmentally sustainable

resources and waste management policies, especially resource efficiency, waste reduction and elimination, the promotion of re-use, repair and recycling, and the development and implementation of the Circular Economy.

As an environmental NGO, and a not-for-profit company with charitable status since 2005, ZWAI also campaigns for the implementation of the UN Sustainable Development Goals, including (but not limited to) Goal 12, Responsible Consumption and Production; Goal 6, Clean Water and Sanitation (having particular regard to the need to avoid wasting water); and Goal 15, to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and to halt and reverse land degradation and halt biodiversity loss.

In addition to responding to many public consultations, members of ZWAI have given presentations on how the European Union has addressed the problem of plastic waste (March 2019), on single-use plastic packaging by the food industry (November 2019), on transforming the construction industry so that it could become a climate neutral (instead of its present position as a major emitter of greenhouse gases and toxicants), and on the recovery and reuse of the phosphorus and nitrogen content of wastewater (2019 to 2022).

It will be clear that ZWAI is primarily concerned with the very serious issue of the misuse of key natural resources, and the problems of discarded substances, materials and goods, whether from domestic, commercial or industrial sources, how these become “waste”, and how such “waste” may be prevented by re-design along ecological principles. These same ecological principles can be applied to the many ways in which we abstract and use water as a resource, and to the equivalent volumes of wastewater produced as a consequence of these uses.

ZWAI is represented on the Irish Government’s Waste Forum and Water Forum (An Fóram Uisce), is a member of the Irish Environmental Network and the Environmental Pillar, and is funded by the Department of Communications, Climate Action and the Environment through the **Irish Environmental Network**.

In 2019 ZWAI became a full member of the **European Environment Bureau** (EEB); and we participate in the **Waste Working Group** of the EEB. Through the EEB, we contribute to the development of European Union policy on waste and the Circular Economy. In November 2021, the EEB established a **Task Force on the Built Environment**; and ZWAI has been accepted as a member of this new group.

3. OUR PRELIMINARY GENERAL OBSERVATIONS

Zero Waste Alliance Ireland (ZWAI) fully supports the EU Soil Strategy for 2030 and welcomes the Commission's proposal for a soil health directive. We also strongly support the principle that the planned directive should be complementary to the EU Green Deal targets for 2030[8], and its subsequent strategies; Farm to Fork[9] and the EU Biodiversity Strategy for 2030.[10] The fact that the proposed soil health directive will contribute to the UN Sustainable Development Goals for 2030 is particularly welcome.[11]

This feedback submission proposes a number of **agroecological** strategies conducive to **sustainable soil use and restoration**. Soil degradation is a wasteful activity that squanders a vital natural resource. Soils provide humans with 98.8% of our food.[12] The human population will likely reach 9.8 billion by 2050; food production will need to rise by 70% from 2005 to 2050 to allow for global food security.[13] Not only are populations increasing, but calorific intake is also rising; daily calorie intake in China in 1963 was 1,400kcal, but stood at 3,100kcal in 2013.

Despite the human population increasing almost three-fold from 1950 to 2015 (2.5 to 7.3 billion people), the proportion of global soil used for cropping increased only slightly from 9.2% to 12.2%. Similarly, cereal production increased almost 400% between 1961 and 2016.[14] Therefore, future food production increases will likely result from further intensification of existing cropland, rather than expansion of land area, though Africa, South America and Asia may see comparatively more cropland expansion. A strategy **to increase food production per hectare** while **conserving and restoring soil health** must be implemented.

Soils also provide wood, fibre, raw materials, physical support for infrastructure; regulating services including flood mitigation, filtering of nutrients and contaminants, carbon storage and greenhouse gas regulation, detoxification of

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[8] EU Green Deal 2030, https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

[9] EU Farm to Fork Strategy https://ec.europa.eu/food/horizontal-topics/farm-fork-strategy_en

[10] EU Biodiversity Strategy for 2030 https://ec.europa.eu/environment/strategy/biodiversity-strategy-2030_en

[11] UN Sustainable Development Goals for 2030, https://sdgs.un.org/goals

[12] Kopittke, P.M., Menzies, N.W., Wang, P., McKenna, B.A. and Lombi, E., 2019. Soil and the intensification of agriculture for global food security. Environment international, 132, p.105078.

[13] ELD Initiative, 2015. Report for policy and decision makers: Reaping economic and environmental benefits from sustainable land management. Economics of Land Degradation Initiative, Bonn.

[14] Kopittke, P.M., Menzies, N.W., Wang, P., McKenna, B.A. and Lombi, E., 2019. Cited above.

wastes, regulation of pests and disease; and cultural services including recreation, aesthetics, heritage values, and cultural identity.[15]

ZWAI supports the goal of the Farm to Fork Strategy of reaching 25% of agricultural land under organic farming by 2030. Organic farming employing organic fertilisers is associated with increased soil health and increased organic matter, and requires about 15% less energy.[16] Our feedback will provide suggestions on how to **minimise soil degradation** in the **remaining 75%** of agricultural land, through the introduction of incentives to support agroecological systems. A policy environment providing incentives and buffers for food producers is essential to allow the scale-up of agroecology.[17] Agricultural habitats make up over 30% of the land surface, together representing one of the largest terrestrial biomes.[18] Therefore, adoption of agroecological principles has a huge potential to support biodiversity planet-wide.

The Commission has already identified a list of measures to improve soil health management in the EU Soil Strategy for 2030, and ZWAI strongly supports these measyres. We will describe some of soil health challenges we are facing in Ireland, and we will propose practical, evidence-based solutions with the aim of encouraging **innovation** in the agricultural sector.

The EU currently relies on a conventional agricultural model which is increasingly dependent on imports, has weak food security, is increasingly vulnerable to world market trends and vulnerable to severe environmental degradation.[19] This vulnerability has been emphasised in recent weeks by the consequences of the attack by Russia on the Ukraine, a country which was for many years described as the “bread basket of Europe”.

A relevant article in the Irish Times, dated Saturday 12 March, and entitled “*Can Ireland feed itself? Yes. A nutritious diet? Not at the moment”*, stated the new situation perfectly:

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[15] Dominati, E., Mackay, A., Green, S. and Patterson, M., 2014. A soil change-based methodology for the quantification and valuation of ecosystem services from agro-ecosystems: A case study of pastoral agriculture in New Zealand. Ecological Economics, 100, pp.119-129.

[16] Clark, M. and Tilman, D., 2017. Comparative analysis of environmental impacts of agricultural production systems, agricultural input efficiency, and food choice. Environmental Research Letters, 12(6), p.064016.

[17] FAO (2018) Scaling Up Agroecology Initiative, available at: http://www.db.zs-intern.de/uploads/1523253471-Initiative.pdf

[18] Foley, J.A., DeFries, R., Asner, G.P., Barford, C., Bonan, G., Carpenter, S.R., Chapin, F.S., Coe, M.T., Daily, G.C., Gibbs, H.K. and Helkowski, J.H., 2005. Global consequences of land use. science, 309(5734), pp.570-574.

[19] Funes-Monzote, F.R., 2009. Agricultura con futuro: la alternativa agroecológica para Cuba. Estación Experimental Indio Hatuey.

> *"Ukraine is one of the world's major grain exporters. Seeds that were destined for Ukrainian fields sit in warehouses unable to reach farmers and the window to sow them is shortening by the day. Crops already in fields will not be harvested as long as Ukraine is under attack, and some crops may already have been destroyed.*
>
> *The loss of Ukraine's exports of major agricultural commodities such as wheat, maize, and sunflower oil, along with the loss of fertiliser supplies from Russia, has serious repercussions for global agriculture and food supplies".*[20]

A further problem area to which we will refer in this submission, is that agricultural intensification, through increased chemical use and homogenization of landscapes, is a major cause of biodiversity loss.[21]

In Ireland, a number of major soil health related issues are beginning to impact negatively on cropland productivity, net carbon emissions, water quality, ecosystem services and biodiversity, unless action is taken quickly. These issues include:

1. Soil erosion;
2. Loss of soils through urban sprawl;
3. Excavation and disposal of soils as waste;
4. Soil compaction;
5. Nitrogen and phosphorus overload, leaching into water bodies;
6. Soil contamination;
7. Peatland drainage; and,
8. Biodiversity decline.

Ireland introduced the Common Agricultural Policy (CAP) in 1962. As of 2020 the CAP was deemed to be 'failing with respect to biodiversity, climate, soil, land degradation as well as socio-economic challenges", (iDiv, 2020). A new CAP is to be introduced in 2023.

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[20] *Can Ireland feed itself? Yes. A nutritious diet? Not at the moment*. Ruth Hegarty; Irish Times, Saturday 12 March 2022 (https://www.irishtimes.com/life-and-style/food-and-drink/can-ireland-feed-itself-yes-a- nutritious-diet-not-at-the-moment).

[21] Tscharntke, T., Grass, I., Wanger, T.C., Westphal, C. and Batáry, P., 2021. Beyond organic farming–harnessing biodiversity-friendly landscapes. Trends in Ecology & Evolution, 36(10), pp.919-930.

4. Is European Union Agricultural Policy Heading in the Right Direction ?

4.1 The View from Ireland

In May 2020, Ireland's largest and most influential environmental NGO, and a member of the European Environment Bureau, wrote that:

> *"Nature has been thrown a lifeline by the EU Commission, with the publication of its landmark 'Farm to Fork' and Biodiversity strategies. An Taisce commends the Commission's newly confirmed 2030 targets, which include:*
>
> - ✓ *Reduction by 50% in overall use of – and risk from – chemical pesticides by 2030 and reduce by 50% the use of more hazardous pesticides by 2030.*
> - ✓ *The reduction of the use of fertilisers by at least 20%.*
> - ✓ *At least 10% of agricultural area to be under high-diversity landscape features.*
> - ✓ *At least 25% of agricultural land to be under organic farming management, and the uptake of agro-ecological practices to be significantly increased.*
>
> *Taken together, these reforms will have far-reaching implications, with nature and biodiversity the biggest winners. Farmers too will see wide-ranging benefits, with diversification and soil fertility being supported and protected by the new measures.*
>
> *For Ireland, the requirement to transition to at least 25% of our farmland to organic systems promises the greatest revolution in farming methods in the modern era. Ireland currently has among the very lowest percentage of farmland managed organically in the EU, at around 2% of total land.*
>
> *This will mean increasing our acreage farmed organically at least 10-fold in the coming decade. This will be challenging and will need to be supported financially, but presents a unique opportunity for the 'green' rhetoric in our agrifood sector to become a reality.*
>
> *Reform of the Common Agriculture Policy (CAP) to focus on true sustainability and the achievement of ambitious climate goals is essential to ensure that EU taxpayers' money is directed towards forms of agriculture that work with nature and respect and protect biodiversity.*

For too long, agricultural policy at EU level has been driven by the interests of multinational agrichemical and agrifood corporations, keen to profit from industrialising the countryside and with scant regard for the devastating consequences of the use and overuse of chemical pesticides, herbicides and fertilisers.

The growing dependency of many farmers on these extremely expensive and ecologically damaging inputs needs to be sharply reversed while the key EU goal of its agricultural systems underpinning food security across the continent is met.

It is ironic indeed that despite Ireland's 'Origin Green' marketing campaign, the EU Commission roadmap is in fact pointing in exactly the opposite direction to the past 10 years of Ireland's agriculture strategies, written by food processors and rubber-stamped by politicians. These have disproportionately benefited the mega landowners and have intensified chemical usage, water, air and climate pollution impacts, and biodiversity losses.

An Taisce also warmly welcomes the Commission's commitment to carrying out a review of the EU promotion programme for agricultural products, with a view to enhancing its contribution to sustainable production and consumption, and in line with the evolving diets.

We also welcome the EU's commitment to promoting more sustainable farming and fisheries practices, reducing deforestation, enhancing biodiversity, and improving food security and nutrition outcomes with its global trading partners.

Good quality food, safely and sustainably produced, is the keystone for longer term European prosperity and resilience in the face of the rapidly growing threat of climate change and biodiversity collapse. The EU Commission has taken an important step toward this goal".

Though some two years old, this positive critique of the European Commission's **Farm to Fork** and **Biodiversity** strategies summarises our own view.

The environmentally damaging consequences of the Common Agricultural Policy (CAP) were also identified in a report by the European Court of Auditors[22], and summarised by An Taisce:[23]

> *"Despite the vast amounts of EU taxpayers' cash being poured into agriculture, including over €100 billion earmarked to reduce greenhouse*

[22] European Court of Auditors, 2021. Common Agricultural Policy and climate — Half of EU climate spending but farm emissions are not decreasing, ECA Report No 16, July 2021.

[23] An Taisce Press Release, 23 June, 2021.

gas emissions from the sector in the last seven years, the new report from the European Court of Auditors (ECA) has just confirmed that agricultural emissions have not come down at all since 2010. Indeed, Irish agricultural emissions have actually increased.

This, according to the ECA, "is because most measures supported by the Common Agricultural Policy (CAP) have a low climate-mitigation potential, and the CAP does not incentivise the use of effective climate-friendly practices".

Livestock emissions account for around half of emissions from agriculture; they have not decreased since 2010, and have risen sharply in Ireland in this period as a result of national government policy.

These emissions, the ECA notes, "are directly linked to the size of the livestock herd, and cattle cause two thirds of them. The share of emissions attributable to livestock rises further if the emissions from the production of animal feed (including imports) is taken into account".

The report also notes that the CAP supports climate-unfriendly practices, such as paying farmers who cultivate drained peatlands, which represent less than 2% of EU farmland but which emit 20% of EU agricultural greenhouse gases.

Drainage of peaty lands in Ireland to convert them to grass production to feed livestock is a major additional source of GHG emissions in Ireland. Overall, Ireland's grassland soils are net emitters of approximately 7 million tonnes of CO_2 per annum.

Crucially, the ECA report notes that "EU law does not currently apply a polluter-pays principle to greenhouse gas emissions from agriculture." Were this to change, the highly emissions and pollution-intensive Irish model of concentrating on large-scale dairy and beef production, primarily for export, would be liable to paying for the pollution it creates.

This would likely render much of this sector unviable and calls into question Irish government policies such as Food Harvest 2020, Food Wise 2025 and the upcoming plan for 2030, all of which are predicated on ever-expanding dairy herd numbers".

An earlier report by James O'Donovan, entitled "*Transition to an Irish Vegan Agricultural System*",[24] highlights major inefficiencies in the global agricultural

[24] James O'Donovan, 2019. "Transition to an Irish Vegan Agricultural System". 96pp.

system, in which 77% of total agricultural land is used to support livestock, producing only 18% of the global calorie supply.

This excellent and very detailed report advocates a transition from meat and dairy production in Ireland to a vegan agricultural system, pointing out that at present (2019), in Ireland, 97% of agricultural land is used for meat and dairy production. In the EU, in 2019, between 69% (€28.5 billion) and 79% (€32.6 billion) of the Common Agricultural Policy (CAP) direct payments were for livestock rearing.

The report recommends all small farms should be converted from animal agriculture to payment for ecosystem services, in total 43,600 small farms. This would potentially free up 0.46 Mha of land for restoration of native forestry, grasslands and wetlands; and these recommendations, if implemented, would directly benefit soil health.

James O'Donovan's report concludes that:

> *"The most effective way for agriculture to change will come from changes in consumer behaviour supported by legal and policy supports for plant based agriculture from national governments and Global Agreements. In Europe and Ireland the CAP needs to change to stop subsidising meat and dairy production and instead support ecosystem services or plant based agricultural systems. A transition to a vegan agricultural system will enable us to:*
>
> - ✓ *stop agriculture from consuming more forests, grasslands and other ecosystems;*
> - ✓ *eliminate pesticides and antibiotics from agriculture;*
> - ✓ *gradually restore ecosystems and biodiversity and thereby reverse climate change;*
> - ✓ *boost the productivity of farms as plant based agriculture is much more efficient;*
> - ✓ *raise the efficiency of water and fertilizer use worldwide;*
> - ✓ *reduce waste in food production and distribution as grains and legumes are much easier to store without deterioration.*
>
> *Globally switching to a whole food plant based diet has the potential to return millions of acres of land to wild habitat, to reverse rainforest destruction, to restore the health and volume of our freshwater rivers and lakes, to prevent further species extinctions, to eliminate billions of tons of pollutants (cow dung, carbon dioxide, methane, nitrous oxides, and ammonia), and to make a major contribution to stabilising and reversing climate change. Gradually as people become conscious of the ethical, environ- mental, economic, and health benefits then they will find the motivation to choose a plant based diet. When this happens is up to all of us. The faster we transition to a non-violent VAS*

(Vegan Agricultural System) the faster we can stem the haemorrhage of biodiversity loss and restore our health and the health of the planetary systems we depend on".

This report on the transformation of Irish agriculture summarises very well our own view of the situation and what should be done at European level to create and implement the necessary changes to a more sustainable form of agriculture which would include a high level of soil protection.

4.2 A Healthy Diet for a Healthy Planet

In January 2019, the EAT–Lancet Commission published an authoritative report on "*Food in the Anthropocene: the EAT–Lancet Commission on healthy diets from sustainable food systems".* The report could best be described as a healthy diet for a healthy planet, and was the subject of much discussion, including unfavourable criticism from organisations with an interest in maintaining the environmentally damaging form of industrial food production which has caused huge biodiversity loss and soil damage.

The report provides much evidence that, while food production systems have the potential to nurture human health and support environmental sustainability, our current food production trajectories threaten both. The EAT–Lancet Commission addresses the need to feed a growing global population a healthy diet while also defining sustainable food systems that will minimise damage to our planet.

The Commission quantitively describes a universal healthy reference diet, based on an increase in consumption of healthy foods (such as vegetables, fruits, whole grains, legumes, and nuts), and a decrease in consumption of unhealthy foods (such as red meat, sugar, and refined grains) that would provide major health benefits, and also increase the likelihood of attainment of the Sustainable Development Goals. This is set against the backdrop of defined scientific boundaries that would ensure a safe operating space within six Earth systems, towards sustaining a healthy planet.

The Lancet Commission identified food production as the largest pressure caused by humans on the environment, and recommended major changes to diets necessary to avoid reduced life expectancy and environmental degradation, including soil degradation. The dietary recommendations call for a **plant-based diet** consisting mostly of fruit, vegetables, whole grains, legumes, nuts, and unsaturated oils, a low to moderate amount of seafood and poultry, and **no or a low quantity of red meat, processed meat, added sugar, refined grains, and starchy vegetables**. The Lancet Commission showed that it is possible to feed a global population of nearly 10 billion people a healthy diet within the

recommended food production boundaries by 2050. Food for these 10 billion humans must be provided **using no additional land**.

At current the current human population of 7.9 billion, replacing meat and dairy production with plant-based food production would result in less cropland required for the same total calorie production, while freeing up a significant proportion of global agricultural land.

This extra land could instead be converted to natural or semi-natural habitats to support soil health, carbon sequestration and biodiversity. The establishment of field margins through EU incentives may be a practical strategy to help achieve this. In Ireland, replacement of meat and dairy agricultural land with forest could help achieve the aims of the EU Green Deal targets for 2030, Farm to Fork strategy and EU Biodiversity Strategy.

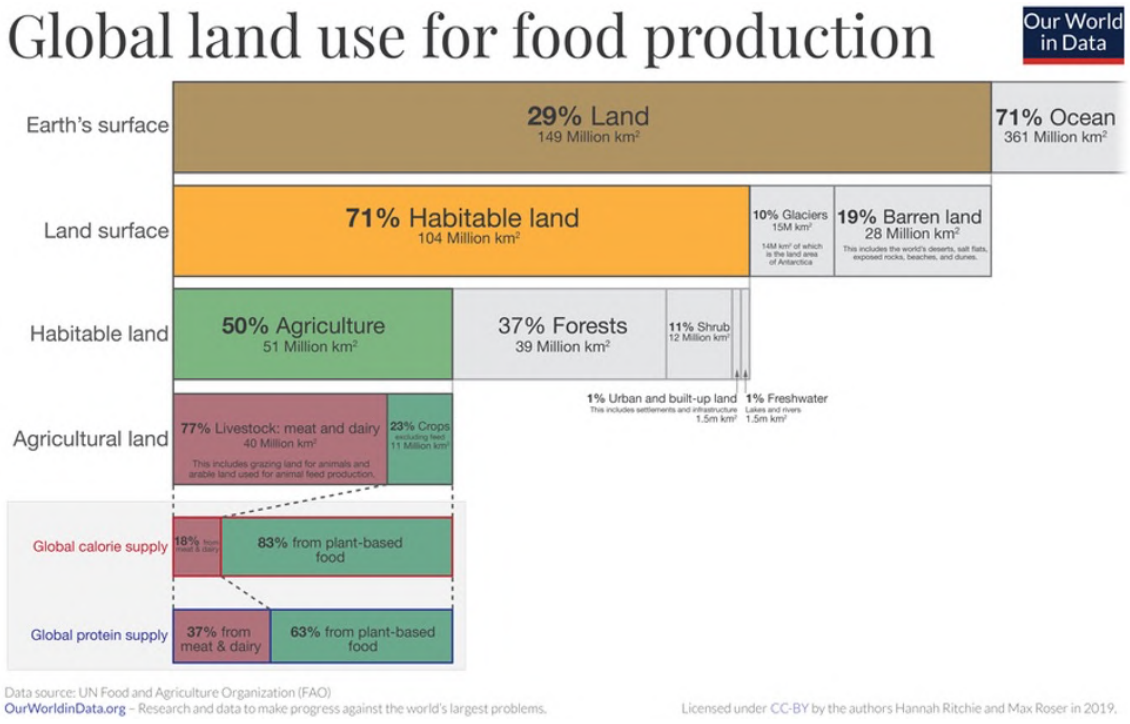

Figure 4.2: Our World In Data. Note the large proportion (77%) of land devoted to producing just 18% of global calorie supply.

It is our recommendation and that the following key messages from the EAT–Lancet Commission report would benefit not only people, human health and ecosystems, but would also benefit the soil globally, as more land could be released from intensive production of meat.

> *"1. Unhealthy and unsustainably produced food poses a global risk to people and the planet. More than 820 million people have insufficient food and many more consume an unhealthy diet that*

contributes to premature death and morbidity. Moreover, global food production is the largest pressure caused by humans on Earth, threatening local ecosystems and the stability of the Earth system.

2. *Current dietary trends, combined with projected population growth to about 10 billion by 2050, will exacerbate risks to people and planet. The global burden of non-communicable diseases is predicted to worsen and the effects of food production on greenhouse-gas emissions, nitrogen and phosphorus pollution, biodiversity loss, and water and land use will reduce the stability of the Earth system.*

3. *Transformation to healthy diets from sustainable food systems is necessary to achieve the UN Sustainable Development Goals and the Paris Agreement, and scientific targets for healthy diets and sustainable food production are needed to guide a Great Food Transformation.*

4. *Healthy diets have an appropriate caloric intake and consist of a diversity of plant-based foods, low amounts of animal source foods, unsaturated rather than saturated fats, and small amounts of refined grains, highly processed foods, and added sugars.*

5. *Transformation to healthy diets by 2050 will require substantial dietary shifts, including a greater than 50% reduction in global consumption of unhealthy foods, such as red meat and sugar, and a greater than 100% increase in consumption of healthy foods, such as nuts, fruits, vegetables, and legumes. However, the changes needed differ greatly by region.*

6. *Dietary changes from current diets to healthy diets are likely to substantially benefit human health, averting about 10·8–11·6 million deaths per year, a reduction of 19·0–23·6%.*

7. *With food production causing major global environmental risks, sustainable food production needs to operate within the safe operating space for food systems at all scales on Earth. Therefore, sustainable food production for about 10 billion people should use no additional land, safeguard existing biodiversity, reduce consumptive water use and manage water responsibly, substantially reduce nitrogen and phosphorus pollution, produce zero carbon dioxide emissions, and cause no further increase in methane and nitrous oxide emissions.*

8. *Transformation to sustainable food production by 2050 will require at least a 75% reduction of yield gaps, global redistribution of*

nitrogen and phosphorus fertiliser use, recycling of phosphorus, radical improvements in efficiency of fertiliser and water use, rapid implementation of agricultural mitigation options to reduce greenhouse-gas emissions, adoption of land management practices that shift agriculture from a carbon source to sink, and a fundamental shift in production priorities.

9. *The scientific targets for healthy diets from sustainable food systems are intertwined with all UN Sustainable Development Goals. For example, achieving these targets will depend on providing high-quality primary health care that integrates family planning and education on healthy diets. These targets and the Sustainable Development Goals on freshwater, climate, land, oceans, and biodiversity will be achieved through strong commitment to global partnerships and actions.*

10. *Achieving healthy diets from sustainable food systems for everyone will require substantial shifts towards healthy dietary patterns, large reductions in food losses and waste, and major improvements in food production practices. This universal goal for all humans is within reach but will require adoption of scientific targets by all sectors to stimulate a range of actions from individuals and organisations working in all sectors and at all scales."*

5. PRACTICAL RECOMMENDATIONS FOR THE IMPROVEMENT OF SOIL HEALTH AND ASSOCIATED BIODIVERSITY

5.1 No-Till Cultivation

Nunes *et al*., (2018)[25] released a study highlighting the effects of long-term no-till cultivation of corn with cover cropping (perennial grass) and crop rotation. The technique demonstrated clear benefits in specific soil health markers including organic matter, active carbon, respiration, and protein content. Four physical soil indicators also showed improvements: available water capacity, water stable aggregation, penetration resistance and water infiltration rate. Additionally, soil chemical indicators were improved: plant available nutrients, pH and total nitrogen. Increased corn yields were recorded in silt loam and a loamy sand soil,

[25] Nunes, M.R., van Es, H.M., Schindelbeck, R., Ristow, A.J. and Ryan, M., 2018. No-till and cropping system diversification improve soil health and crop yield. Geoderma, 328, pp.30-43.

whereas clay loam soils showed soil improvement but no apparent increase in yields.

Oehl and Koch, (2018)[26] compared the diversity of Arbuscular Mycorrhizal Fungi (AMF) in two adjacent vineyards in Palatinate in South-West Germany. The grape variety "Pinot Gris" was grown for 39 years under different soil cultivation and different fertilization strategies in each field. One field was tilled to remove vegetation by a rotary cultivator periodically; 24 species of AMF were recorded. The other field was maintained with a no-till technique and was permanently under perennial ryegrass (*Lolium perenne*); 34 species of AMF were recorded. The study concluded that the no-till technique above all resulted in the increased diversity of AMF, while fertilisation type affected diversity only to a minor degree.

Figure 5.1 **No-till soybeans drilled into a cover crop. Cereal rye and annual ryegrass used as a grass cover crops before soybeans, a legume grain crop. Photo by Dr. João Moraes Sá.**

AMF are a promising option for increasing yields in sustainable agroecological systems and food security[27]. Experiments by Zhang *et al*., (2018)[28] found that AMF increased the yields of major cereal crops: maize, wheat, sorghum and rice. Inoculation of seed with AMF lead to an increase of fungal colonization of 29%, while reduced tillage alone led to fungal colonisation increase of 7%, Lekberg and

[26] Oehl, F. and Koch, B., 2018. Diversity of arbuscular mycorrhizal fungi in no-till and conventionally tilled vineyards. J. Appl. Bot. Food Qual, 91, pp.56-60.

[27] Rillig, M.C., Sosa-Hernández, M.A., Roy, J., Aguilar-Trigueros, C.A., Vályi, K. and Lehmann, A., 2016. Towards an integrated mycorrhizal technology: harnessing mycorrhiza for sustainable intensification in agriculture. Frontiers in Plant Science, 7, p.1625.

[28] Zhang, S., Lehmann, A., Zheng, W., You, Z. and Rillig, M.C., 2019. Arbuscular mycorrhizal fungi increase grain yields: A meta-analysis. New Phytologist, 222(1), pp.543-555.

Koide, (2005)[29]. It is likely that inoculation combined with no-till techniques will lead to a greater rate of AMF colonisation and resulting higher grain yields.

5.2 Perennial Crops

Efforts are underway to develop **perennial versions** of grain crops, such as intermediate wheatgrass, (*Thinopyrum intermedium)*. A study by Daelemans *et al*., (2022)[30] concluded that perennial crops are a viable alternative to annual crops since perennial systems have long-lasting and extensive root networks, minimising soil health degradation. Therefore, they help reduce wasteful erosion and nutrient leaching from soil.

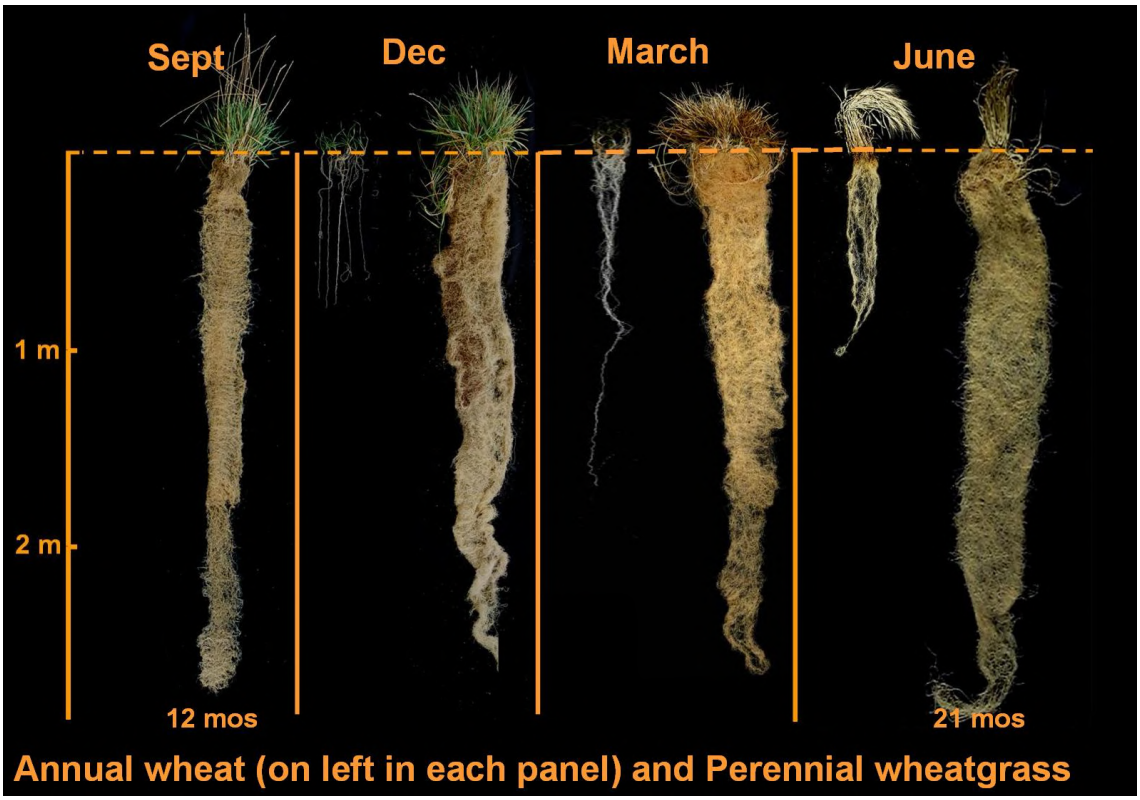

Figure 5.2 Comparison of wheat roots (at left in each panel) to those of Thinopyrum intermedium in four seasons, Jerry Glover.

[29] Lekberg, Y. and Koide, R.T., 2005. Is plant performance limited by abundance of arbuscular mycorrhizal fungi? A meta-analysis of studies published between 1988 and 2003. New Phytologist, 168(1), pp.189-204.

[30] Daelemans, R., Hulsmans, E. and Honnay, O., 2022. Both organic and integrated pest management of apple orchards maintain soil health as compared to a semi-natural reference system. Journal of environmental management, 303, p.114191.

Current global food security mainly relies on **annual grains**—cereals, oilseeds, and legumes—planted on almost 70% of croplands, which combined supply a similar portion of human calories.[31]

These crops grow for one season and must be re-sown year after year. Perennial grain crops, however, remain for 2 years or more and can develop much more extensive root systems. Kreitzman *et al*., (2020) [32] highlight that perennial crops make up a small but significant (4.5%), and growing portion of global cropland. The paper emphasises the high productivity of some perennial crops, meaning a transition from annual crops may not entail yield losses in some regions. If land under perennial crops increases in a linear fashion, by 2040, 956 million tons of carbon (MtC) could be sequestered, with associated soil health benefits. Alfalfa is an example of a useful perennial crop which is nitrogen fixing, can be cut or grazed for animal feed and produces edible seed. Other perennial crops include kale, asparagus, rhubarb, oil palm and fruit and nut trees.

5.3 Crop Rotation

D'Acunto *et al.,* (2018)[33], reported soil microbial diversity and activity increased with increased crop rotation diversity.

Figure 5.3: Maize and wheat can be grown in rotation

[31] Monfreda, C., Ramankutty, N. and Foley, J.A., 2008. Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000. Global biogeochemical cycles, 22(1).

32 Kreitzman, M., Toensmeier, E., Chan, K., Smukler, S. and Ramankutty, N., 2020. Perennial staple crops: yields, distribution, and nutrition in the global food system. Frontiers in Sustainable Food Systems, p.216.

33 D'Acunto, L., Andrade, J.F., Poggio, S.L. and Semmartin, M., 2018. Diversifying crop rotation increased metabolic soil diversity and activity of the microbial community. Agriculture, Ecosystems & Environment, 257, pp.159-164.

Woźniak et al., (2019)[34] outlined the advantages of crop rotation versus spring barley monocultures. The rotation sequence was: peas – spring barley – winter wheat, while the cereal monoculture was: spring barley – winter wheat – winter wheat. There are clear economic and environmental benefits to crop rotation. Higher barley grain yield was recorded, with associated higher profits. Grain yield in crop rotation systems was recorded as 25.6% higher than in cereal monoculture. Plants make better use of the available nutrients in soil when grown in rotation. Weeds, pathogens, and pests are less prevalent due to the host crops changing year by year.

According to Woźniak and Soroka (2015)[31] and Shahzad *et al*., (2016)[35] cereal monoculture leads to increased infestation with weeds and, consequently, a decrease in yield. Weeds which are highly competitive with the host cereal will become pervasive and persistent in the soil. This requires heavy application of herbicide to control, which negatively impacts soil health and biodiversity, and cuts into potential profits.

Sugar beet production in Ireland is currently resurging. This presents an opportunity to establish good rotational practices to maximise soil health and profitability. Koch *et al*., (2018)[36] suggest that leguminous crops such as pea offer the potential for higher sugar beet yield with lower N-fertilizer doses. Considering Ireland's cool, wet climate, the ideal legumes for rotation are soybean and clover. Intercropping with clover may result in decreased weeds and increased soil nitrogen. This may result in lower herbicide and nitrogen applications.

34 WOŹNIAK A., SOROKA M. Structure of weed communities occurring in crop rotation and monoculture of cereals. International Journal of Plant Production, 9 (3), 487, 2015.

35 SHAHZAD M., FAROOQ M., JABRAN K., HUSSAIN M. Impact of different crop rotations and tillage systems on weed infestation and productivity of bread wheat. Crop Protection, 89, 161, 2016.

36 Koch, H.J., Trimpler, K., Jacobs, A. and Stockfisch, N., 2018. Crop rotational effects on yield formation in current sugar beet production–results from a farm survey and field trials. Frontiers in Plant Science, 9, p.231.

5.4 Intercropping

Figure 1.4: Pea and barely intercropping mix. The peas can fix nitrogen to support the growth of the barley. The crop can be harvested together for protein-rich animal feed, or separated for other uses, picture: James Hutton Institute.

Intercropping is a common practice in organic farming, where alternatives to chemical fertilisers have been sought.

Jensen *et al*., (2020)[37] analysed the intercropping of legumes and cereals. Increased Nitrogen-use efficiency was noted in intercropping systems, leading to a theoretical reduction in fossil-based nitrogen fertiliser use by 26% on a global scale. The study suggests intercropping has advantages including increased yield stability and yield per unit area, reduced pests, reduced agrochemical demand and improved soil biodiversity. However, challenges still exist in harvesting the mixed crops, further study and funding by the EU may help solve this.

Romaneckas *et al*., (2020)[38] designed an experiment to investigate the effect of intercropping sugar beet with clover, barley, and ambient weeds as a green manure. Under minimal fertilisation, soil nitrogen, phosphorous and potassium increased, while sulphur was decreased. Sugar beet yield was significantly decreased, while the quality was unchanged. These results show the necessity for further study into intercropping to maintain high yield, improve soil health while decreasing dependence on fertilisers.

[37] Jensen, E.S., Carlsson, G. and Hauggaard-Nielsen, H., 2020. Intercropping of grain legumes and cereals improves the use of soil N resources and reduces the requirement for synthetic fertilizer N: A global-scale analysis. Agronomy for Sustainable Development, 40(1), pp.1-9.

[38] Romaneckas, K., Adamavičienė, A., Šarauskis, E. and Balandaitė, J., 2020. The impact of intercropping on soil fertility and sugar beet productivity. Agronomy, 10(9), p.1406.

5.5 Cover Crops

Figure 5.5: Native forb/grass covers are used in organic and sustainable vineyards, picture: eVineyard.

The proposed Soil Health Directive highlights the need for "measures that can contribute to reducing nutrient losses by at least 50% without deterioration in soil fertility (resulting in the reduction of fertiliser use by at least 20%". Implementation of Cover crops is one such measure. Cover crops can reduce runoff volume, sediment loss, and nitrate leaching, but may have smaller effects on reducing dissolved nutrients in runoff.[39]

Cover crops generally do not compete with the main crop for resources and help keep down weeds.[40] Cover crops with fibrous root systems are especially effective in halting soil erosion.[41] Mango growers who implemented diverse permanent plant cover in their orchards were very satisfied.[42]

Cottney et al., (2021)[43] investigated the integration of cover crops in arable systems in Ireland. The cover crops were grown over winter to improve sustainability, instead of leaving the land fallow. In the Republic of Ireland, subsidisation is available to farmers for cover cropping, but not in the North of

[39] Blanco-Canqui, H., 2018. Cover crops and water quality. Agronomy Journal, 110(5), pp.1633-1647.

[40] Sharma, P., Singh, A., Kahlon, C.S., Brar, A.S., Grover, K.K., Dia, M. and Steiner, R.L., 2018. The role of cover crops towards sustainable soil health and agriculture—A review paper. American Journal of Plant Sciences, 9(9), pp.1935-1951.

[41] De Baets, S., Poesen, J., Meersmans, J. and Serlet, L., 2011. Cover crops and their erosion-reducing effects during concentrated flow erosion. Catena, 85(3), pp.237-244.

[42] Gloanec, C., 2015. Outils et enjeux de la coordination d'un projet partenarial. Outils d'évaluation et observatoire des impacts. Deguine J.-P., Gloanec C., Schmitt T.(eds), pp.12-21.

[43] Cottney, P., Williams, P.N., White, E. and Black, L., 2021. The perception and use of cover crops within the island of Ireland. Annals of Applied Biology, 179(1), pp.34-47.

Ireland. These two regions of Ireland are in close proximity geographically, being part of the one country under different jurisdictions; therefore the subsidisation scheme in the Republic of Ireland most likely plays a major role in influencing how and why cover crops are used.

In the North of Ireland, 54% of farmers have planted cover crops before compared to a higher proportion of 77% in the Republic of Ireland . This demonstrates the higher rate of and increased willingness to plant cover crops in the Republic of Ireland, possibly because of a better awareness and level of agricultural training.

Therefore, further subsidies implemented in the EU will likely increase the planting of cover crops, leading to improved soil health, and reduced waste fertilisers.

5.6 Agroecological Crop Protection (ACP)

Agroecological Crop Protection (ACP) is the innovative application of Agroecology to crop protection. APM is built on two pillars, biodiversity and soil health, in order to make agroecosystem less susceptible to biotic stresses, for example herbivorous insects and weeds.[44]

Figure 5.6: The ladybird (*Coccinella magnifica*) is perhaps the most recognisable insect predator. Picture: National Geographic.

The concept of Integrated Pest Management (IPM) was popular in the 1980s and 1990s. It treated insect populations as allies or enemies, to be controlled with combined chemical and biological methods, with the aim of minimising damage to the ecological environment. A new paradigm shift of emphasising the importance of the farm as part of a **functioning ecosystem** is now gaining momentum. The application of ACP has the potential to improve soil health by encouraging ecosystem friendly practices, while reducing chemical control

[44] Deguine, J.P., Aubertot, J.N., Flor, R.J., Lescourret, F., Wyckhuys, K.A. and Ratnadass, A., 2021. Integrated pest management: good intentions, hard realities. A review. Agronomy for Sustainable Development, 41(3), pp.1-35.

methods. A reduction of pesticides, herbicides and fungicides is correlated with higher soil biodiversity and soil health markers.

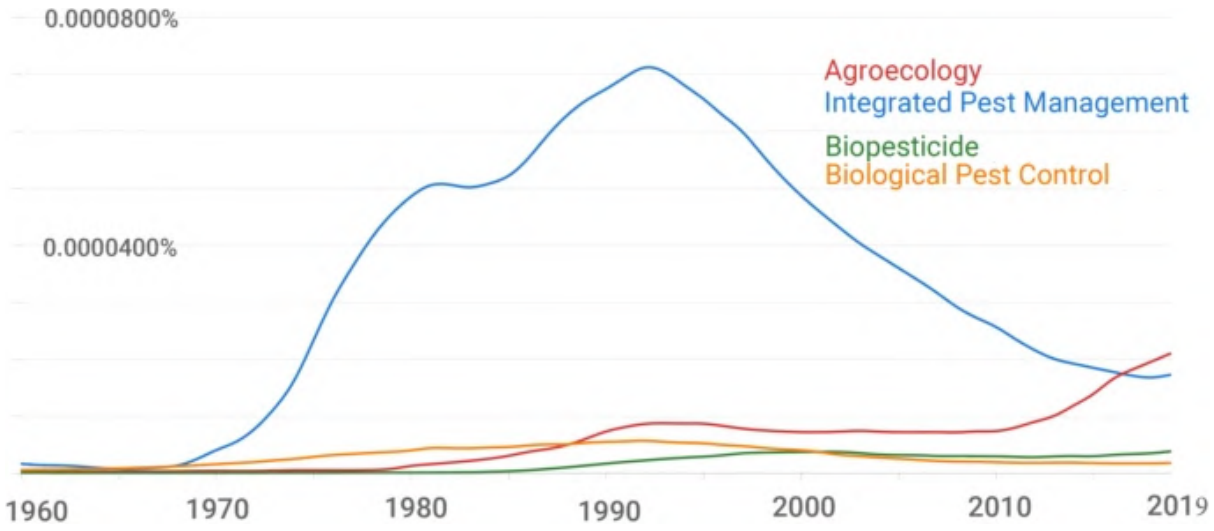

Table 5.6.1: Frequencies of 4 key terms, found in sources printed between 1960 and 2019, Deguine et al., 2021. Note the recent rise in Agroecology versus the decline in Integrated Pest Management

An extensive long-term ACP experiment by Deguine *et al*., (2018) [45] was undertaken in mango orchards in La Réunion over many years, (It is, to the author's knowledge, the first large-scale experiment of its kind. The experiment showed that a transition from chemical crop protection (with its limits and disadvantages) to agroecological protection, is possible.

Mango growers adopted simple agroecological practices such as 100% vegetation cover with irrigation in the orchards and the elimination or near-elimination of insecticides and herbicides to encourage **functional biodiversity**. Costs were reduced by 35% without loss of production, except for a few situations. For context, La Réunion is a biodiversity hotspot, and many agroecological techniques were already adopted on the island.

It represents a significant step towards demonstrating that Agroecological Crop Protection is viable for farming environments (see table on next page).

The use of broad-spectrum herbicides to control weeds is prevalent in Ireland. Glyphosate is also used to stop the growth of barley, and to dry it out for more

[45] Deguine, J.P., Jacquot, M., Allibert, A., Chiroleu, F., Graindorge, R., Laurent, P., Lambert, G., Albon, B., Marquier, M., Gloanec, C. and Vanhuffel, L., 2018. Agroecological protection of mango orchards in La Réunion. In Sustainable Agriculture Reviews 28 (pp. 249-307). Springer, Cham.

efficient harvesting.[46] Additional glyphosate applications to fields after barley harvesting removes the wild plant cover that otherwise would provide protection from water and wind erosion. Excessive use of herbicide is wasteful and leads to soil degradation.

Data	Conventional farming	Agroecological farming
Inputs		
Pesticides	€ 1614	€ 39
Mass traps (80 traps/ha)	€ 480	€ 480
Irrigation (for 2,990 m3)	€ 299	€ 299
Total inputs	€ 2393	€ 818
Labour		
Phyto monitoring	€ 473	€ 473
(time spent)	(50 h)	(50 h)
Phyto treatments	€ 1,031	€ 258
(time spent)	(16 h)	(4 h)
Surveillance of mass trapping	€ 525	€ 525
(time spent)	(55 h)	(55 h)
Rotary slashing after cutting	€ 516	€ 516
(time spent on tractor)	(8 h)	(8 h)
Chemical weed control	€ 645	€ 0
(time spent)	(10 h)	
Mowing beween rows	€ 645	€ 322
Mowing rows	€ 0	€ 151
(time spent on strimmer)		(16 h)
Harvesting	€ 1106	€ 1106
(time spent)	(117 h)	(117 h)
Mowing	€ 908	€ 908
(time spent)	(96 h)	(96 h)
Total labour	€ 5849	€ 4259
Production cost	**€ 8242**	**€ 5077**

Table 5.6.1: Economic breakdown of costs of mango cultivation on La Réunion, conventional vs agroecological.

[46] Roseboro, K., "Why Is Glyphoste Sprayed On Crops Right Before Harvest?" Mar. 5, 2016, Ecowatch.

Liu *et al*., (2016) [47] found that herbicide application led to increased soil erosion in rubber plantations in China. Cerdà *et al.,* (2021), [48] recorded significant soil erosion of bare soil resulting from glyphosate abuse in an irrigated peach plantation in Spain.

With frequent annual use, residual concentrations of glyphosate in soil likely builds up and persists. Only about 5% of the applied dose reaches the target weed while the remaining amount contacts the soil surface, is expelled by roots of plants intercepting the glyphosate, or is released from plant tissues upon decomposition. [49]

5.7 Agroforestry & Tree Planting

Figure 5.7: Wheat and walnut tree agroforestry. Picture: Christian Dupraz.

In 2015, Ireland had the second lowest percentage tree cover in the EU at 11.03%, and was ranked 144th out of 189 countries globally (FAO, 2015). The report by O'Donovan cited earlier in this submission recommended that farmers in Ireland should be paid to convert 1.7 Mha of land to native broadleaf forests to reach the European average of 34% (2.5 Mha) forest cover. A study by Wang et al., (2020) in Northern China found that reforestation is an effective method for

[47] Liu, H., Blagodatsky, S., Giese, M., Liu, F., Xu, J. and Cadisch, G., 2016. Impact of herbicide application on soil erosion and induced carbon loss in a rubber plantation of Southwest China. Catena, 145, pp.180-192.

[48] Cerdà, A., Daliakopoulos, I.N., Terol, E., Novara, A., Fatahi, Y., Moradi, E., Salvati, L. and Pulido, M., 2021. Long-term monitoring of soil bulk density and erosion rates in two Prunus Persica (L) plantations under flood irrigation and glyphosate herbicide treatment in La Ribera district, Spain. Journal of Environmental Management, 282, p.111965

[49] Kremer, R., Means, N. and Kim, S., 2005. Glyphosate affects soybean root exudation and rhizosphere micro-organisms. International Journal of Environmental Analytical Chemistry, 85(15), pp.1165-1174.

preventing water and wind erosion of soil, and the total erosion reduction has a linear relation to the increase of forest land area.

Jalón *et al*., (2018) [50] conducted a case study on a silvo-arable experimental plot of poplar trees planted in 1992 in Bedfordshire, Eastern England. Compared to a regular arable system, soil erosion loss in the silvo-arable system was reduced by about 50%. The authors expect the reduction would be even greater on sloped ground.

A study by Ruseva *et al*., (2015) [51] found that financial incentives were successful in increasing tree planting by landowners. This is promising for the implementation of other soil health management strategies. Financial incentives should be available for farmers who adopt agroecological soil protection practices.

5.8 Field Margins

Figure 5.8: Species-rich field margin surrounding a barley field

Agricultural intensification currently increases crop yield, yet is associated with biodiversity loss and soil degradation. It can be considered a wasteful practice. Organic farming is widely believed to be the only alternative to intensive farming for protecting soil health and biodiversity. Organic agriculture provides roughly a 30% increase in species richness, at the cost of considerable yield losses. To feed the world's population using only organic agriculture, more land would need

50 García de Jalón, S., Graves, A., Palma, J.H., Williams, A., Upson, M. and Burgess, P.J., 2018. Modelling and valuing the environmental impacts of arable, forestry and agroforestry systems: a case study. Agroforestry systems, 92(4), pp.1059-1073.

51 Ruseva, T.B., Evans, T.P. and Fischer, B.C., 2015. Can incentives make a difference? Assessing the effects of policy tools for encouraging tree-planting on private lands. Journal of Environmental Management, 155, pp.162-170.

to be converted to cropland, destroying valuable ecological habitats in the process[13]. Therefore, a viable alternative is required.

One possibility is to reduce the size of fields currently under intensive agriculture, while establishing strips of semi-natural habitat on the periphery. Semi-natural habitats have much greater ecological functioning than even organic cropland. De Cauwer *et al.*, (2006)[52] measured decreased nitrogen pollution of groundwater and increased plant biodiversity after establishing grass/forb margins in arable fields after 5 years. A width of 5 metres was recommended. Semi-natural grasslands provide many ecosystem functions including **protection of soils from erosion, protection of soil biodiversity, regulation of water quality, nutrient cycling, reduction of groundwater nitrogen and CO2 sequestration**[53],[54]. Therefore, ZWAI encourages further subsidies to encourage the establishment of semi-natural margins in arable land to help minimise the wasteful deterioration of soil and water.

Grass margins were proposed in many European countries in response to arable land degradation. When grass margins are implemented in adjacent fields, wildlife corridors are created. A conserved lattice of natural or semi-natural land will promote wildlife and plant movement to maintain genetic and population vigour, recolonize connected habitats after local extinction, and allow migration in response to climate change.[55] Soil bacterial and fungal diversity increases after conversion of cropland to grassland, peaking after 30 years.[56] High crop yields can be maintained in the arable field while promoting biodiversity at the margins. Crop diversification, smaller fields, and establishment of semi-natural habitat patches can have greater positive effects on biodiversity than organic certification[57].

52 De Cauwer, B., Reheul, D., Nijs, I. and Milbau, A., 2006. Effect of margin strips on soil mineral nitrogen and plant biodiversity. Agronomy for sustainable development, 26(2), pp.117-126.

53 Ferrarini, A., Serra, P., Almagro, M., Trevisan, M. and Amaducci, S., 2017. Multiple ecosystem services provision and biomass logistics management in bioenergy buffers: A state-of-the-art review. Renewable and Sustainable Energy Reviews, 73, pp.277-290.

54 Hopkins, A., 2009, May. Relevance and functionality of semi-natural grassland in Europe–status quo and future prospective. In International workshop of the SALVERE-Project (pp. 9-14).

55 Resasco, J., 2019. Meta-analysis on a decade of testing corridor efficacy: what new have we learned?. Current Landscape Ecology Reports, 4(3), pp.61-69.

56 Yang, Y., Li, T., Wang, Y., Dou, Y., Cheng, H., Liu, L. and An, S., 2021. Linkage between soil ectoenzyme stoichiometry ratios and microbial diversity following the conversion of cropland into grassland. Agriculture, Ecosystems & Environment, 314, p.107418.

57 Sirami, C., Gross, N., Baillod, A.B., Bertrand, C., Carrié, R., Hass, A., Henckel, L., Miguet, P., Vuillot, C., Alignier, A. and Girard, J., 2019. Increasing crop heterogeneity enhances multitrophic diversity across agricultural regions. Proceedings of the National Academy of Sciences, 116(33), pp.16442-16447.

5.9 Peatland Management

85% of wetlands worldwide have been lost since 1700, (IPBES, 2019)[58].

Figure 5.9: Undrained peatland can act as a carbon sink. Picture: International Peatland Society.

Peatlands are important globally for their role in storing carbon and therefore climate regulation[59], while undrained peatlands likely play a major role in water purification and in certain cases delaying runoff and preventing floods[60]. Peatlands also support biodiversity and are valuable recreation areas. Therefore, peatland management should be considered as important as soil and water management. Half of Europe's raised bogs are found in Ireland.

In their natural state peatlands act as long-term sinks for atmospheric carbon dioxide, and a persistently high water table is necessary for this function. Peatlands are the most important long-term carbon store in the terrestrial biosphere; they sequester and store atmospheric carbon for thousands of years, and the peatlands in the northern hemisphere alone store approximately 450 billion tonnes of carbon.[61]

Undisturbed peatlands accumulate carbon from the air at a rate of up to 0.7 tonnes per hectare per year; and the Wildlife Trust in Britain has estimated that a

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58 IPBES., 2019, (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) "Media Release: Nature's Dangerous Decline 'Unprecedented', Species Extinction Rates 'Accelerating'.", available at: https://ipbes.net/news/Media

59 Joosten, H., Sirin, A., Couwenberg, J., Laine, J. and Smith, P., 2016. The role of peatlands in climate regulation. In Peatland restoration and ecosystem services: science, policy and practice (Vol. 2016, pp. 63-76). Cambridge, UK: Cambridge University Press.

60 De Groot, R., Stuip, M., Finlayson, M. and Davidson, N., 2006. Valuing wetlands: guidance for valuing the benefits derived from wetland ecosystem services (No. H039735). International Water Management Institute.

61 Most of the following information is taken from the IPCC website, and we are indebted to the IPCC for making available a useful summary of the role of peatlands in mitigating the effects of climate change.

2m deep peatland stores 8,000 tonnes of carbon per hectare. In Ireland, peatlands are estimated to store 1085 Megatonnes (Mt) of carbon, i.e., 53% of all soil carbon stored in all of Ireland on just 16% of the country's land area.

The delicate balance between production and decay easily causes peatlands to become carbon sources following interference. A drop in the water table due to drainage, peat removal, burning and other human influences leads to significant releases of some greenhouse gases but conversely a decrease in others (e.g. methane). Between 1990 and 2000 up to 23 Mt of soil carbon has been lost from Irish peatlands, mainly due to industrial peat extraction. It is therefore vital to maintain an elevated water table on peatland habitats to prevent the large-scale release of these gases.

In Ireland the long-term carbon storage function of 47% of our original peatland area has been severely diminished through domestic and mechanical peat extraction. Because of the large emissions of CO_2 from degraded peatlands, re-wetting and restoring them is one of the most cost-effective ways of avoiding anthropogenic greenhouse gas emissions.

In a natural peatland system, the movement of greenhouse gases (e.g., methane and carbon dioxide) between the peatland and the air is complex. Although peatlands accumulate carbon over the long term, they both fix and emit carbon dioxide and release considerable amounts of methane, a by-product of anaerobic decomposition. Drainage of a peatland upsets the accumulation process and leads to a vast increase in the amount of carbon dioxide released to the atmosphere from the peatland, a by-product of aerobic decomposition.

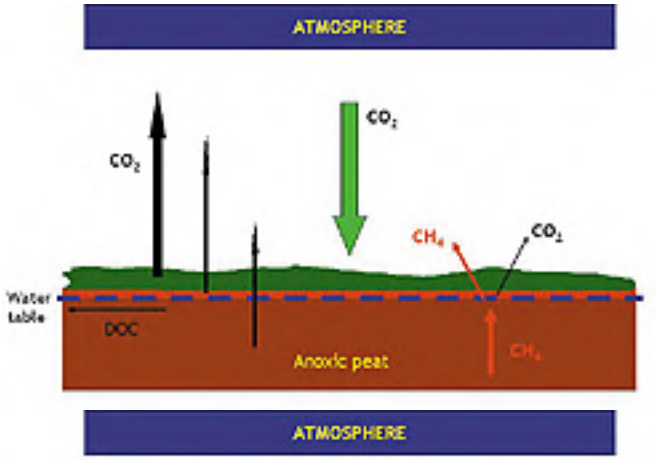
The diagrams below, prepared by Wilson and available on the IPCC website illustrate these concepts.

The Millennium Ecosystem Assessment 2005 predicted that by the end of the 21st Century, climate change would be the major cause of biodiversity loss; and this is clearly happening at an accelerated rate. The predicted increase in temperature and the changes in rainfall patterns, coupled with centuries of habitat loss, are likely to have a major impact on peatland ecosystems.

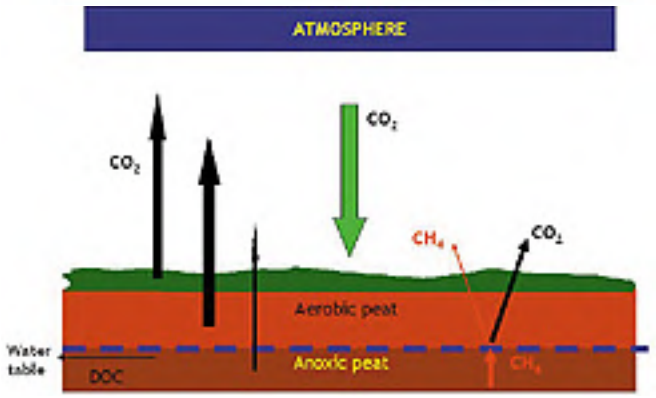
As peatland formation in Ireland is strongly linked to climate, any changes in the climate will have an adverse effect on our peatlands. The most recent years been the warmest decade in the Irish climate record; and the global statistics are daunting:

- 17 of the 18 warmest years on record have been in this 21st century;
- Each of the last three decades has been successively warmer than any preceding decade since 1850;

- The period from 1983 to 2012 was the warmest 30-year period of the last 800 years in the Northern Hemisphere, and likely to be the warmest 30-year period of the last 1400 years;
- Since 1870, human activities have emitted some 2,145.5 $GtCO_2$-e;
- The carbon budget remaining is only 754.5 GtCO2-e, if we want to to limit human-induced warming to less than 2 degrees C;
- We have used 74% of the maximum quota, leaving only 26%;



Carbon dynamics in an intact peatland with a high water table. Source: David Wilson



Carbon dynamics in an intact peatland with a low water table. Source: David Wilson

- At the current rate of emissions, that 26% will give us a little bit less than 18 years, i.e., until 2037; and,
- To stabilise warming, CO_2 and other GHG emissions will have to be reduced to zero; and, the faster this zero point is achieved, the lower the level at which global warming will stabilise; and there must be an equitable transition to zero emissions.

Analysis of the Irish meteorological monitoring network has shown that already the south and east of the country are experiencing drier summers, while the north and west are experiencing wetter winters. As a result, changes are anticipated in the distribution of peatlands, with south-easterly sites most at risk initially. However, this may be counter-balanced by better conditions for peat accumulation further north, thanks to increased rainfall in winter.

The Impact of Climate Change on Peatland Species

The MONARCH (Modelling Natural Resource Responses to Climate Change) programme 2001 is a long-term programme developed to assess the impact of predicted climate change on wildlife in Britain and Ireland. It points to where climate is likely to become favourable or unfavourable for species, thereby influencing their future distribution.

MONARCH predicts a loss in suitable climate space in Ireland for the Skylark (*Alauda arvensis*) and a gain in suitable climate space for the Marsh Fritillary butterfly (*Euphydryas aurinia*). The dominant vegetation of most bogs is *Sphagnum* moss, of which there are many species. MONARCH investigated the likely future extent of *Sphagnum papillosum*. Its climate space is likely to remain and possibly enlarge across Ireland. A similar response is seen for other bog species such as Bog Myrtle (*Myrica gale*) and White-beaked sedge (*Rhynchospora alba*). But more northern species will probably lose a significant part of their distribution, such as Cloudberry (*Rubus chamaemorus*), which may find conditions too warm and could disappear entirely from Ireland.

As most peatland species are extreme habitat specialists they may be unable to adapt to the rapidly changing climatic conditions that are predicted. Further research is needed on the environmental requirements of each individual species so as to determine which species are likely to be most at risk. Unfortunately, at present, relatively little is known about the vulnerability of most of our bogland plant and animal species to enable a more accurate assessment. A survey of 850 native plant species carried out by Dr Peter Wyse Jackson of the National Botanic Gardens of Ireland showed that 171 (20%) of Ireland's flora appears to be particularly vulnerable to climate change up to 2050. 34 of these vulnerable species occur on peatlands, including Fen Violet (*Viola persicifolia*), Bog Orchid (*Hammarbya paludosa*), Cloudberry (*Rubus chamaemorus*) and Marsh Saxifrage (*Saxifraga hirculus*).

In conclusion, the current management of Irish peatland resources is generally not sustainable and is having major negative impacts on climate and biodiversity. Strict protection of intact peatlands is critical for the conservation of biodiversity and to maintain their carbon storage and sequestration capacity and associated ecosystem functions.

Rehabilitation and integrated management of peatlands can generate multiple benefits including maintaining biodiversity and mitigating climate change, as well as decreasing poverty and combating land degradation.

A recent and very relevant paper by Wilson, Farrell, Mueller, Hepp and Renou-Wilson[62] demonstrates that rewetting of industrial cutaway peatlands offers a number of important benefits in terms of GHG exchange. The authors conclude that the re-establishment and, more importantly, maintenance of hydrological conditions characteristic of natural peatlands leads to a reduction in CO_2 emissions from the peat and to a potential carbon saving or avoided loss. Furthermore, the re-establishment of the carbon sequestration capacity of the peatland through re-colonisation by appropriate vegetation communities may further enhance carbon storage.

This three-year study highlighted the importance of long-term GHG monitoring in order to assess more accurately the capacity of peatland to sequester carbon. The advantages offered by climate on the west coast of Ireland (persistent rainfall, cool temperatures), coupled with an inherently nutrient-poor peat substrate mean that rewetted industrial cutaway peatlands in this region could be a prime location for climate change mitigation.

Peatlands are therefore an important component of EU soils, and deserve the highest level of protection.

This submission was researched and written by two members of Zero Waste Alliance Ireland: Jack Coffey (member and researcher) and Jack O'Sullivan (founder member and Director). The assistance of Orla Coutin (researcher and membership secretary) is much appreciated, together with the encouragement given to the ZWAI team by Ollan Herr (Director and Chair of the Board of ZWAI.

16 March 2022

[62] Rewetted industrial cutaway peatlands in western Ireland: a prime location for climate change mitigation? D. Wilson, C. Farrell, C. Mueller, S. Hepp and F. Renou-Wilson; *Mires and Peat*, Volume 11 (2013), Article 01, 1–22, http://www.mires-and-peat.net/

ZERO WASTE ALLIANCE IRELAND

Towards Sustainable Resource Management

Feedback to the European Commission on a Proposed Directive on Soil Health – Protecting, Sustainably Managing and Restoring EU Soils

APPENDICES

1. **Transition to an Irish Vegan Agricultural System, James O'Donovan, Oct-2019**
2. **Can Ireland feed itself? Yes. A nutritious diet? Not at the moment. Ruth Hegarty. Irish Times, Saturday 12 March 2022.pdf**

Zero Waste Alliance Ireland is a member of

EEB European Environmental Bureau

and

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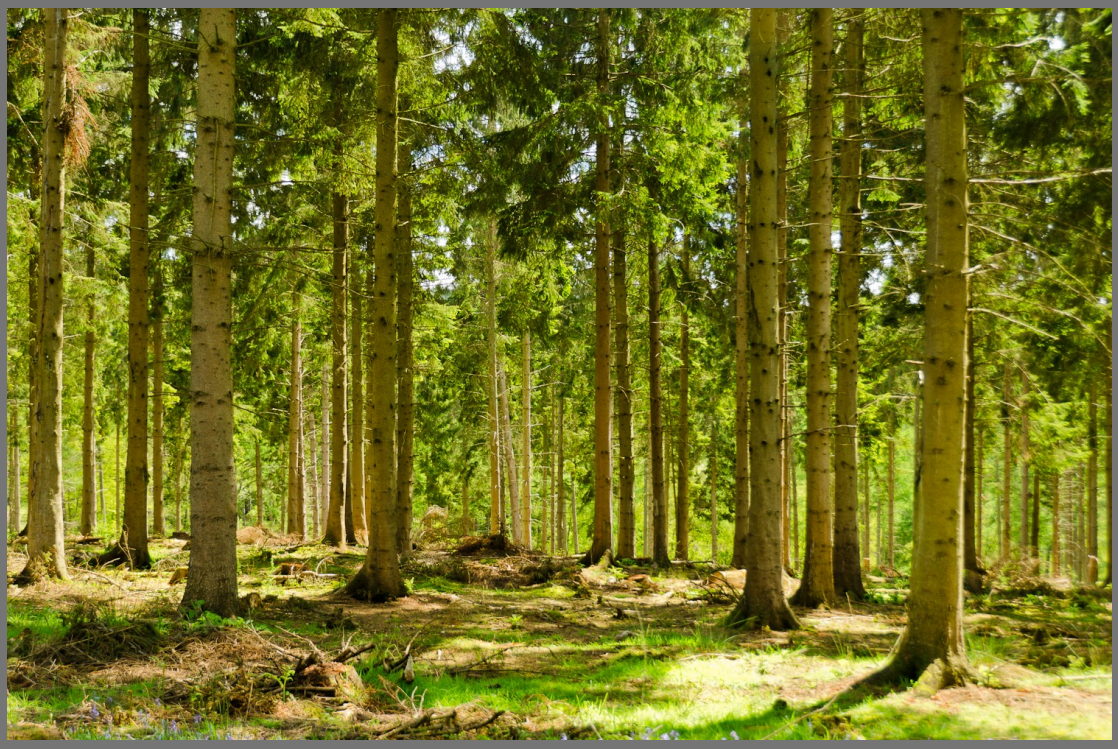

Transition to an Irish Vegan Agricultural System

Report Author: James O'Donovan

About the Author:

James O'Donovan is the current chair of the Cork Environmental Forum, a local environmental organisation raising awareness and implementing projects in Cork City and County. He provides training on sustainability issues to community groups in the region while also preparing policy submissions on food and water related issues.

James qualified in Civil Engineering from University College Cork and subsequently completed an MSc in Holistic Science at Schumacher College, one of the leading centres for sustainability in the UK.

He worked in the US for 8 years, and in South Africa for seven years, working as a training provider in community water and sanitation. He has also worked in India, Nepal, Mexico and Central America.

James became vegetarian in 1991 after reading John Robbins' book Diet for a New America, and went vegan in 2011 after waking up to the impacts of the dairy industry. In 2015 he and a colleague, Bronwyn Slater, set up 'Vegan Sustainability' - an on-line magazine with articles highlighting the enormous benefits of veganism: www.vegansustainability.com.

He also works as a volunteer helping to run meditation retreats in Ireland and Europe. He is interested in contributing to a more just and ethical society through the promotion of personal emotional wellbeing and vegan sustainable living.

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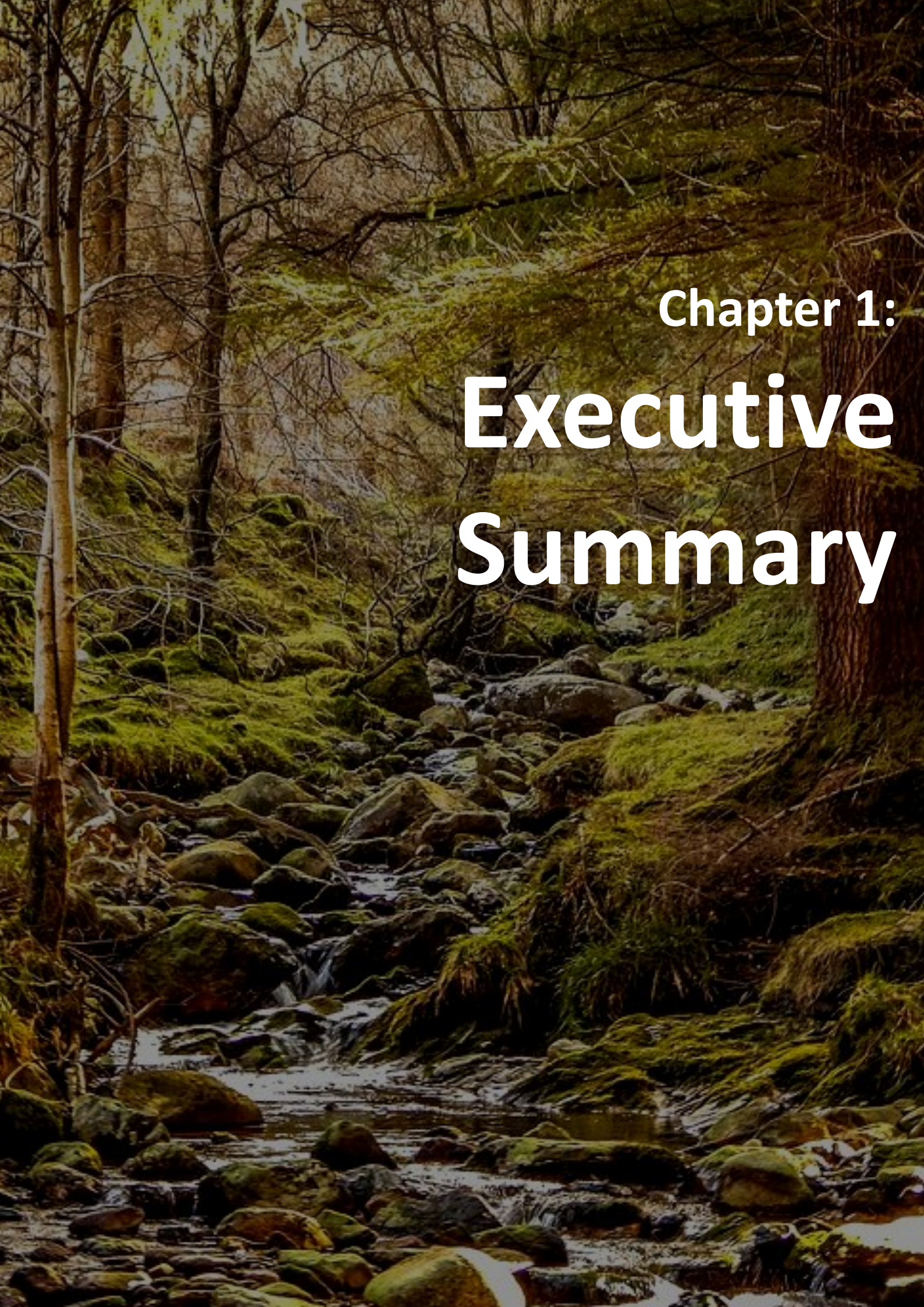


Chapter 1:
Executive Summary

1.1 Summary of Report Statements

Land Use and Biodiversity Impacts:

1. Globally 50% of habitable (ecologically productive) land is occupied by agriculture. An average of 42% of all land in Europe is used for agriculture.
2. There was a 60% decline in populations of vertebrate (mammal, bird, fish and amphibian) species between 1970 and 2014. A 60% decline in the human population would be equivalent to emptying N. and S. America, Africa, Europe, China and Oceania.
3. **Globally agriculture, fishing, hunting and wildlife trade is responsible for 70-80% of vertebrate biodiversity loss** and intensive agriculture and agricultural poisons are the main causes of land invertebrate (insects, etc.) loss.
4. In Europe "over 71 % of agricultural land is dedicated to feeding livestock". Agriculture occupies 70% of the land in Ireland – approx. 4.9 Million Hectares (Mha). A further 11% of land is used primarily for commercial forestry – 0.77 Mha (some of this is on farms). The EU average for forestry is 34%.
5. According to the EPA State of the Irish Environment 2016 Report, only 7% of land based ecosystems are considered to be in a favourable ecological condition.
6. **In Ireland 97% of agricultural land is used for meat and dairy production.**
7. Without meat and dairy consumption, global farm land use **could be reduced by more than 75%** – an area equivalent to the US, China, EU and Australia combined – **and still feed the world**.

2017 Conversion of Forests to Soy Monoculture. Argentina.
Photo: Jim Wickens, Ecostorm

Water Use and Biodiversity Impacts:

1. Globally Freshwater Biodiversity is declining faster than any other ecosystem with an 83% decline in freshwater mammals, birds, amphibians, reptiles and fishes since 1970.
2. Nitrogen pollution costs the European Union up to €320 billion a year and over 80% of EU agricultural nitrogen emissions to water are linked to animal agriculture.
3. Over 50% of Irish estuaries, lakes and rivers fail to meet Good Environmental Status.
4. Ireland's Farm Animals produce 50 times more waste than the human population. This waste is spread untreated on our land polluting its streams, rivers, and lakes.
5. 30% of Ireland's 170,000 private wells are estimated to be contaminated by *E. coli.*
6. Ireland has the highest rate of groundwater VTEC (verotoxigenic *E. coli*) contamination in Europe (EFSA, 2016). VTEC is a type of the bacterium *E. coli*. that can be fatal.
7. 97% of the water we use is embodied in products (87% in food). A plant based agricultural system would reduce Ireland's Agricultural Water Footprint by 50%.

Antibiotic and Pesticide Use in Irish Agriculture:

1. Globally human medicine accounted for 40,000 tonnes of antibiotic use in 2013 while Animal Agriculture and Aquaculture accounted for 131,000 tonnes or **76%** of antibiotic use worldwide.
2. In the EU, 33,000 people die annually due to infections caused by resistant bacteria, costing an estimated €1.5 billion each year.
3. Two thirds of antibiotics sold in Ireland are administered by farmers.
4. 103.4 tonnes of veterinary antibiotics were sold in Ireland in 2016.
5. 3,135 tonnes of pesticide/herbicide/fungicide **active ingredients** were sold in Ireland in 2016.
6. When you eat meat and dairy in Ireland you are eating products from animals that have been fed Genetically Modified Maize and Soy.

Income, Subsidies and Employment in Irish Agriculture:

1. In 2016 Ireland had €13.2 billion (11%) of exports and €9 billion (12%) of imports of agri-food products. By comparison our total fuel imports amount to €4.7 Billion.
2. Globally there are an estimated $0.5 trillion of agricultural subsidies for animal agriculture. In Europe between 69% (€28.5 billion) and 79% (€32.6 billion) of the Common Agricultural Policy (CAP) direct payments is for animal agriculture.
3. There are 137,500 farms in Ireland. Large farms account for 4 Mha and small farms for 0.46 Mha. 40,800 large farms earn less than €10,000 a year and 43,600 small farms earn an average of under €3,000. **So 62% of all farms earn a FFI that is well below the poverty line.**
4. The average Large Farm Family Income (FFI) for 2018 was **€23,306. On average 74% of income was Subsidies** with an average payment per farm of **€17,292**.
5. **In 2018 73% (68,342) of large farms occupying 2.54 Mha received 113-158% of their income from subsidies.** These farms earned 22-38% of the average industrial wage. 78% of large farms were in receipt of an off-farm income source.
6. In 2018 Direct payments account for 111% of FFI in the Border, 106% in the West, 95% in the Midlands region.
7. In 2018, there were only 30,000 Viable large farms in Ireland on 1.28 Mha.
8. Small Farms received 173 – 219% of FFI from subsidies in 2015. 88% of small farms were in receipt of an off-farm income source.
9. In 2013 average Income for Small Farms (2018 – 32% of farms) was under €3,000.
10. In 2017 primary agriculture employed 101,227 people (5% of the workforce) and food processing a further 46,712 (2.3% of the workforce).
11. A third of farm holders are over 65 years of age. The average

farmer age is 56.

12. Beef and sheep production make up 82% of all farms and occupy 70% of agricultural land (3.1 Mha). These farms receive an average of 113 - 219% of their income from subsidies across both large (2018) and small (2013) farms.

Food Security:

1. **Globally 83% of Agricultural land is used for animal agriculture producing only 18% of food calories consumed** (Poore and Nemecek, 2018). 60% of agricultural land is used for beef production producing only 2% of food calories consumed.
2. The global meat and dairy food system converts 8.2 billion tonnes of feed and fodder to 0.46 billion tonnes of animal products. This wastes six times the FAO's current global food waste estimate of 1.3 billion tonnes.
3. 1,103.4 million tonnes of animal feed were produced globally in 2018. **This could feed 5.6 billion people.** The World Food Programme purchases just 3 million tonnes of food each year for all its programmes.
4. "The Industrial Food Chain uses at least **75%** of the world's agricultural resources but provides food to less than **30% of the world's people.**"
5. The Irish agricultural land area under Tillage has dropped by 75% since 1851. Historically Ireland's farmers have already succeeded in growing grains, legumes and vegetables on a large scale. **Ireland's land and climate is suitable for a highly productive plant based agricultural system.**
6. Over the last century Irish crop yields per hectare have increased by approx. 300%.
7. In 2017 Ireland produced enough food to feed 23.3 million people on 4.9Mha. This consisted of plant based food calories for 2.7 million on 1.5% of the land and animal based food calories to feed 20.6 million people (on 98.5% of the land).
8. In 2017 Ireland fed enough food calories for 127 million people to farm animals who produced enough calories to feed 20.6 million people – wasting 85% of the calories.
9. A plant-based diet can feed **31-47 times** more people than a diet of beef - based on Irish Agricultural Yields for 2017.
10. **Using 88% of the current land area we could produce enough plant based food calories to feed 150 million people (a 640% increase in food calorie output).**

11. 1.7 Mha would produce enough plant based food calories for 70 million people (a 300% increase in food calorie output) based on 2017 average yields.
12. **Irish meat and dairy production converts 47 million tonnes of feed and fodder to approx. 2 million tonnes of meat, dairy and eggs.** This is **34 times** more food waste than the current Irish EPA National food waste estimate of 1.3 million tonnes.
13. Ireland's annual animal feed imports could provide enough food for 15 million people.

Economic Security:

1. In Europe between 2005 and 2013, 3.7 million farms ceased to exist, a drop of 26% in eight years, (from 14.4 million to 10.7 million). In Ireland between 1991 and 2016 there has been a drop of 33k farms (19% in 25 years) leaving 137,500 farms in 2016.
2. 73% of the Large Farms in Ireland are cattle and sheep farms whose Family Farm Income (FFI) is 22-38% of the industrial wage.
3. 44% (40,800) of large farms earn less than €10,000 a year.
4. In 2015, average income for 52,300 (43,600 in 2018) small farms was under €3,000.
5. **62% of all farms earn a FFI that is well below the poverty line.**
6. A third of farm holders are over 65 years of age. The average farmer age is 56.
7. A 2 ha plant based family farm in Cork produces an income of €35,000/ha/year.
8. This small plant based family farm produces a per hectare income that is 90-125 times the income for sheep and beef farms in Ireland and 33 times the average per hectare income of dairy farms and 50 times for Tillage farms.

Climate Change and Agriculture:

1. Globally agriculture directly contributes about 15–23% of all GHG emissions, which is comparable to transportation. But including all food system processes and food waste then the total contribution is 29%.
2. A vegan diet would reduce the EU's **agricultural** emissions by 70%.
3. Ireland currently generates 60 million tonnes (Mt) of Carbon Dioxide equivalent (CO_2 eq) and Irish agriculture 20 Mt of CO_2 eq.
4. Ireland is legally bound by the Paris Climate Agreement to a 40% reduction in EU-wide emissions by 2030 compared to 1990.
5. A VAS (Vegan Agricultural System) would reduce Irish agricultural emissions by 17 Mt to 43 Mt per year.
6. By converting 2.8 Mha to forest and native grasslands and wetlands the total sequestered is estimated to be about 15 Mt of CO_2 eq/yr. **Ireland's Total Emissions would drop to 28 Mt per Year – a reduction of 53%.**
7. The Global carbon sequestration potential of reverting 41% of current grasslands and pasturelands to native forests was estimated to be 265 Billion Tonnes (Gt) of Carbon (C) (on 19.6 MKm^2 of land area). This is greater than the 240 GtC that has been added to the atmosphere since the industrial era began, showing that a global vegan transition has the potential to **fully reverse climate change**.
8. The International Energy Agency's World Energy Investment Outlook states that $53 trillion in cumulative investment in energy supply and in energy efficiency is required to 2035 to get the world onto a 2°C emissions path. A global transition to Vegan Agriculture with reforestation is by far the most cost effective way to sequester carbon dioxide and stabilise the climate system.
9. A 40% reduction in Ireland's emissions will cost an estimated €35 billion up to 2030. However with a transition to a

VAS, Ireland could use existing agricultural subsidies to reduce our emissions by 53% without needing any increased taxes.

Health Impacts and Benefits of a Vegan Agricultural System:

1. **Unhealthy diets are the leading cause of ill health worldwide**, with 800 million people hungry, 2 billion malnourished and a further 2 billion overweight or obese.
2. Globally dietary changes towards a plant based diet can prevent approximately **11 million deaths per year**, 19% to 24% of total deaths among adults. A global transition to a Vegan Diet would also save more than US$1 trillion in costs per year.

The Future of Food:

1. Globally small farms feed over 70% of people with less than 25% of the resources – including land, water and fossil fuels. Globally the Industrial Food Chain uses at least 75% of the agricultural resources but provides food to less than 30% of people.
2. In 2018 there were over 600,000 Vegans, Vegetarians and people reducing meat in Ireland.
3. The Netherlands' agri-food exports are nearly seven times Ireland's agri-food exports on less than half (40%) of Ireland's agricultural land. Over half of the Netherlands' exports are plants based foods.
4. Legumes are currently produced on only 1.5% of the arable land in Europe compared with **14.5% on a worldwide basis**.

5. In Ireland plant based foods produce 10-20 times more protein per hectare than beef.
6. According to the Rodale 30 Year Farm System Study the yields from organic farming match those of conventional farming which uses pesticides and fertilisers. Organic farming builds soil organic matter, uses 45% less energy, produces 40% less greenhouse gas, and is more profitable than conventional methods.
7. A Global Study found that, "Organic agriculture can feed the world with lower environmental impacts. If food waste is reduced and arable land is not used to produce animal feed, then 'land use under organic agriculture remains below' the current area of farmland."
8. A vegan-organic farm can generate **868% more** income than conventional and **421% more** income than organic agriculture practices per kilogram of produce.

1.2 Overall Report Recommendations

Global Legal Structure:

1. An Internationally binding Declaration of the Rights of Other Species needs to be passed that enshrines the rights of other species to live free from harm and violence. This would provide the ethical underpinning for a non-violent society in harmony with all other species.
2. Globally, A Framework Convention on Food Systems would provide the global legal structure and direction for countries to act on improving their food systems so that they become engines for better health, environmental sustainability, greater equity, and ongoing prosperity.

Payments for Ecosystem Services:

3. We recommend that farmers are paid for ecosystem services including biodiversity restoration, carbon sequestration, flood reduction, water purification, pollination, etc.
4. We recommend that approx. 55,000 large farms would transition to payments for ecosystem services. The remaining 37,720 large farms would focus on plant based food production. This would reduce the agricultural land area for large farms from 4 Mha to 1.7 Mha - a reduction of 2.3 Mha.
5. We would recommend that all small farms are converted from animal agriculture to payment for ecosystem services. This would see the conversion of 43,600 small farms to ecological enterprises. This would potentially free up a further 0.46 Mha of land for restoration of native forestry, grasslands and wetlands.
6. Dairy farmers would need to transition from Dairy to generating income from plant based food, fibre and fuel crops. Appropriate subsidies and technical and training supports would be needed to ensure that income levels are maintained and enhanced.

Economic Security:

7. When farmers can receive their current CAP payments as Payments for Ecosystem Services this would increase the income of large beef and sheep farmers as follows (based on 2018 figures):
   - Cattle rearing farmers from an average income of €8,318 to the subsidy of €13,109.
   - Cattle Other farmers from an average income of €14,408 to the subsidy of €16,257.
   - Sheep farmers from an average income of €13,769 to the subsidy of €18,812.
8. When small farms transition to payment for ecosystem services this could potentially increase the income of small land owners from approx. €3,000 to €5,500.

CAP Payments:

9. We recommend the elimination of subsidies for meat and dairy production and for animal feeds and instead subsidies should be directed towards plant based foods for direct human consumption and ecological restoration.
10. In Ireland a total of €1.07 Billion of subsidies would be allocated to payment for ecosystem services. €730 million in subsidies would be paid to the remaining 37,720 farmers providing a subsidy of €19,350 on conversion to plant based agriculture.
11. We would recommend that no CAP payment should exceed €50,000 per farm. "Only 1.4% of Irish farmers get payments over €50,000 but they account for almost 10% of all such payments." This would allow the distribution of €180 million to smaller farmers. Very large profitable farms should not be subsidised.

Forestry:

12. Farmers would be paid to convert 1.7 Mha of land to native broadleaf forests to reach the European average of 34% (2.5 Mha) forest cover.

Native Grasslands, Meadows, Bog and Wetlands:

13. Farmers would be paid to convert a further 1.1 Mha to native grasslands, meadows, and bog and wetlands.

End the use of anti-biotics in Irish food production:

14. A transition to a VAS will eliminate the 103,400 Kg of veterinary antibiotics being used annually for meat and dairy production.

Food Security:

15. Using **38%** of the current agricultural land, 1.7 Mha, we could produce enough plant based food calories for 70 million people – a 300% increase in food calorie output.
16. We would no longer import animal feeds (which have sufficient calories to feed 15 million people).

Organic, Plant-based Agriculture:

17. The conversion to an organic plant-based agricultural system will prevent 3.135 million kg of pesticide active ingredients being sprayed annually into the environment.

Renewable Energy:

18. Ireland's Farmers / Land owners will play a significant role in Ireland's transition to renewable energy – primarily wind and solar with some small scale biomass for local combined heat and power schemes. In the future, payments may not be tied to land area but to ensuring that all rural landowners are getting a living wage for contributing to meeting the state's legal and ethical obligations to current and to future generations.

Agricultural Emissions Reduction:

19. A VAS would reduce agricultural emissions by 17 Mt to 43 MTonnes per year. The total sequestered by converting 2.8 Mha to native forest, grasslands and wetlands is estimated to be about 15 Mt of CO_2 /yr. **Ireland's Total Emissions would drop to 28 MTonnes per Year – a reduction of 53%.**

Land Use:

20. Overall, total Irish agricultural land use should be reduced from 4.5 Mha to 1.7 Mha, a reduction of 2.8 Mha.

Vegan Food Production Systems:

21. Re-establishing a large horticultural sector while expanding tillage and field crops.
22. Large scale investment in the development of plant based meat and dairy alternative products.
23. Agricultural Education, Research Facilities and Support Services for a VAS.
24. Substituting imported foods that can be grown in Ireland.
25. Government and Private Sector Investment in high-tech greenhouses.
26. Trade protection to allow Irish plant based markets to become competitive.

Chapter 2:
Introduction

Chapter 2: Introduction

''Unhealthy diets are the leading cause of ill health worldwide, 800 million people are currently hungry, 2 billion malnourished and a further 2 billion people overweight or obese".....''Global food production threatens climate stability and ecosystem resilience. It constitutes the single largest driver of environmental degradation and transgression of planetary boundaries. Taken together the outcome is dire. A radical transformation of the global food system is urgently needed. Without action, the world risks failing to meet the UN Sustainable Development Goals and the Paris Agreement." – EAT Lancet Commission Report, 2019.

At global, regional and national levels the food system and the food we eat is the leading cause of human illness and ecosystem and biodiversity loss. The EAT Lancet Commission Report calls for a transition to a plant based or primarily plant based food system in order to save **"approximately 11 million deaths per year."** The Lancet Commission Study makes it very clear that without a food system transformation human society will be unable to live within the ecological safe operating space as defined by the planetary boundaries. At Vegan Sustainability Magazine we believe that to protect the rights of all species we need a global transition to a Vegan Food System. In this report we explore the impacts of a transition to a vegan agricultural system (VAS) in Ireland. We examine the costs and benefits of this transition on the economy, employment, land use, food security, Green House Gas (GHG) Emissions, biodiversity, and health. This report focuses on the land based food production system only and we will examine the urgent need to immediately shut down the fishing industry and transition to a plant centred marine food production system in a separate report.

This report defines a VAS as a non-violent Agricultural System. A VAS does not use animals in any way – neither breeding, raising, using or killing any animals, nor relying on animal fertilisers for growing plants. A VAS does not use any pesticides or other poisons. This will require rapid change from our current meat and dairy centred food system where violence has become normalised. Once people understand the enormous benefits of a non-violent plant based agricultural system then veganism will continue to move steadily into the mainstream as a key solution in the broader transition to a sustainable, socially and economically just society. Vegan Sustainability Magazine welcomes feedback, suggested additions or corrections, which you can submit by e-mailing info@vegansustainability.com

2.1 Justifications for a Vegan Ireland

Globally the case for moving towards a VAS is based on the understanding that the use of animals for food, clothing, experimentation, entertainment, or any other purpose:

1. results in the profound suffering and exploitation of sentient animals;
2. is unnecessary for human health and wellbeing;
3. is so wasteful of land and food suitable for human consumption that it is globally the main cause of hunger and famine;
4. produces various land, water and air pollutant streams (animal manures (bacteria, viruses, worms, protozoa), nitrates and phosphates, carbon dioxide, methane, ammonia, antibiotic residues, slaughterhouse wastes, dairy production wastes, etc.);
5. is a main driver of climate change globally, along with fossil fuel combustion;
6. is the leading cause of biodiversity loss by degrading and eliminating ecosystems;
7. is the main user of fresh water globally;
8. is responsible for 80% of tropical deforestation;
9. is the leading cause of anti-microbial resistance;
10. is the source of a range of diseases that have been transferred from farmed animals to the human population and to wild populations of other species (zoonotic diseases).

Photos: Sailesh Rao

On the other hand, a VAS enables the global community to meet many of the SDGs including:

1. globally it will save the lives of 70 – 100 billion sentient animals (105 million animals are killed in Ireland each year);
2. it will save an estimated eleven million human lives and help eliminate global hunger;
3. it can reverse biodiversity loss and the loss of forests, grasslands and other ecosystems;
4. it can reverse climate change in combination with a transition

to renewable energy;
5. it will save the global economy trillions of dollars;
6. it eliminates some of the main sources of land, water and air pollution;
7. it reduces the global use of antibiotics by over 50%.

Right Livelihood
Work is of vital importance to us all. It ensures our economic independence and security and allows us to support our families, put food on the table, pay for electricity, heating, transport, communication, entertainment and other services. Work is the energy that enables our various social systems to function such as our health, education, justice, manufacturing, and food systems. It allows us to contribute to society and is a significant part of our identity. If we are to transition to a more non-violent society then we need to recognise that not all work is good work. Work that involves unethical behaviour or encourages unethical behaviour should be curtailed and if possible eliminated. We should begin to immediately end employment in the trade of products like weapons, pesticides and other poisons, meat, fish, and live animals. This would have enormous benefits for biodiversity and ecosystems, for human health and climate change.

2.2 A Roadmap to a Vegan Agricultural System

This report considers the costs and benefits of a VAS under the following headings.

Land use and Biodiversity Impacts
This section looks at how much land is currently being used for animal farming globally, in the EU, and in Ireland. It also highlights some of the historical changes in agricultural land use in Ireland and the growth of commercial forestry plantations since the 1920's. Finally this section describes the impacts of agriculture on species, ecosystems and soil health and the potential for biodiversity to recover as native forests, grasslands, and wetlands are restored and pollutants eliminated.

Water Use and Biodiversity Impacts
This section describes the impacts of agriculture on Ireland's streams, rivers, lakes and drinking water from a water quality and a water quantity perspective. This section also briefly describes some of the impacts on Ireland's aquatic species and ecosystems and some of the water ecosystem benefits of ecological restoration.

Antibiotics and Pesticide Use by Irish Agriculture
This section describes the extent of antibiotic and pesticide use in Ireland. A VAS is an organic plant based agricultural system. This would eliminates the need for antibiotics and pesticides and the huge problems of anti-microbial resistance and pesticide pollution. There is also an introduction to some of the other major environmental impacts of Irish Agriculture.

Income, Subsidies and Employment in Irish Agriculture
- How much the current food production system contributes to and costs the economy?
- The economic status of Irish farmers and the role of subsidies in family farm income.
- Employment in animal agriculture industries and how these jobs are distributed between farming and food processing?

Food Security
- How many people are fed by our current meat and dairy centred agricultural system and how many could be fed by a VAS.
- How a VAS would free up agricultural land which could be reused for many other beneficial purposes.

Climate Change and Irish Agriculture
This section examines how agricultural emissions are reduced by a VAS, and the sequestration potential of large areas of land being returned to native forests and grasslands.

Potential Health Benefits of a VAS
Here we examine the benefits of a plant based diet on human health and health care costs.

Restructuring Subsidies to support a transition to a VAS
This section estimates how subsidies would change from animal agriculture to a plant based agricultural system and payments for ecosystem services.

The Future of Food
This section presents a number of initiatives and case studies that illustrate that a sustainable vegan agricultural system is possible in Ireland and internationally. It explores the lessons that can be learned from the Netherlands' Agricultural Model and presents the latest research on Organic Agriculture. It shows how a VAS will reduce our food imports and enhance our overall food security. Finally it presents a number of case studies on the development of EU plant based foods and businesses that are replacing meat and dairy.

2.3 Vegan Agriculture Transition Principles

This study makes use of economic, agricultural, health, and environmental data from recognised Irish Government and semi-state bodies together with selected peer reviewed scientific papers, as well as some international and EU Reports. The proposed changes to land use and agriculture are guided by the following principles:

- There should be no negative effects on the availability of food to provide for a healthy population. The changes will result in different food types being available, but the levels of all essential macro and micro nutrients will be maintained or enhanced.
- The proposed changes should maintain or improve current living standards.
- Costs, including financial and other externalities such as health and climate change mitigation costs, should not be deferred to future generations.
- The changes should aim to restore biodiversity and water quality while maintaining food and water security.
- The changes should allow Ireland to meet its climate change targets and other EU goals as outlined in the Water Framework Directive, the Habitats Directive, etc.
- Any economic and employment impacts should be minimised and alternative employment options outlined.
- Rural Ireland will play a crucial role in the transition to a productive, healthy, ethical, ecological land management approach, and accurate valuation of ecosystem services and innovative financial incentives will be required to enable land owners to work together in order to restore and strengthen

vital ecosystem services.

- Where economic and employment impacts are unavoidable, the costs of these must be met by society in general and not left to landholders and workers to bear. No individual or family should be financially disadvantaged.

This last point, ***shared responsibility***, is crucial to ensure fairness. Moving to a VAS will result in significant land use changes impacting the lives and livelihood of many thousands of people. The changes will result in major benefits to the environment, climate, and human health and these benefits will be shared by all of Irish society. But these changes in land use for ecological restoration and reforestation will need to be sustained into the future. To ensure that rural Ireland is not asked to shoulder this burden by themselves, the economic costs of these changes must be shared by society and not just with individual landholders.

Integrated Planning

The food production system is an important sector but it is still just a part of the much larger economy which is a part of a much wider society which is embedded in and dependent on nature. In order for rural Ireland to prosper and to reverse current rural out migration a number of other initiatives should be immediately implemented. These are beyond the scope of this report but are broadly in line with the Recommendations of the Citizens Assembly on Climate Change and the Report of the Joint Committee on Climate Action and include:

- Deep retrofit of housing starting with lower income homes to reduce heating bills, fuel use and their resultant emissions.
- Large scale and rapid deployment of (on-shore and off-shore) wind turbines and solar water heaters and photo voltaic panels. Many of these systems should be community owned using a variety of ownership models from cooperatives to dedicated percentage of company shares owned publicly to state and privately owned systems.
- Investment in public transport infrastructure and services. These should be low cost or even free. This will enhance health and well-being by increasing social cohesion and community in rural areas while reducing transport GHG emissions.

EAT Lancet Commission Report

2.4 Scientific Consensus on the need for a Food System Transformation

Over the last twenty years thousands of scientific reports have been published detailing the harmful impacts of animal agriculture on biodiversity, human health and climate change. In this section we briefly present three of these studies which describe the negative impacts of animal agriculture on a global level. The first two studies state unequivocally that it will not be possible to meet the Sustainable Development Goals (SDGs) for ecological and human well-being without moving to a predominately plant based or a completely vegan food system.

EAT-Lancet Commission Report 2019, Healthy Diets from Sustainable Food Systems

This report states that although "there is substantial scientific evidence that links diets with human health and environmental sustainability" there is still an "absence of globally agreed scientific targets for healthy diets and sustainable food production" and this "has hindered large-scale and coordinated efforts to transform the global food system."

To address this critical need, the EAT-Lancet Commission convened 37 leading scientists from 16 countries in various disciplines including human health, agriculture, political sciences and environmental sustainability. The report calls for "nothing less than a new global agricultural revolution." The commission evaluated which diets and food production practices together will enable achievement of the Sustainable Development Goals and the Paris Agreement. The overall goal of the report is to develop global scientific targets for both **sustainable food production** and for **healthy diets**.

Defining a Sustainable Food Production System

The report describes how industrial agriculture is devastating the environment, as forests are destroyed and billions of cattle emit climate-warming methane. Prof. Johan Rockström, one of the report's lead authors states: "Humanity now poses a threat to the stability of the planet. Global food production threatens climate stability and ecosystem resilience. It constitutes the single largest driver of environmental degradation and transgression of planetary boundaries. Taken together the outcome is dire. A radical transformation of the global food system is urgently needed. Without action, the world risks failing to meet the UN Sustainable Development Goals and the Paris Agreement."

According to the report: "Interacting biogeophysical systems and processes in the Earth system, in particular between the climate system and the biosphere, regulate the state of the planet. The Commission focuses on six of these, (shown below), which are the main systems and processes affected by food production and for which scientific evidence allows the provision of quantifiable targets.

Scientific Target Boundaries for Control Variables of Six Key Earth System Processes

Earth system process	Control variable	Boundary (Uncertainty range)
Climate change	GHG emissions	5 Gt CO_2-eq yr^{-1} (4.7 – 5.4 Gt CO2-eq yr^{-1})
Land-system change	Cropland use	13 M km^2 (11–15 M km^2)
Freshwater use	Water use	2,500 km^3 yr^{-1} (1000–4000 km^3 yr^{-1})
Nitrogen cycling	N application	90 Tg N yr^{-1} (65–90 Tg N yr^{-1}) * (90–130 Tg N yr^{-1})**
Phosphorus cycling	P application	8 Tg P yr^{-1} (6–12 Tg P yr^{-1}) * (8–16 Tg P yr^{-1})**
Biodiversity loss	Extinction rate	10 E/MSY (1–80 E/MSY)

*Lower boundary range if improved production practices and redistribution are not adopted.
**Upper boundary range if improved production practices and redistribution are adopted and 50% of applied phosphorus is recycled.

The EAT-Lancet Report, 2019

These systems and processes are being increasingly recognized as necessary parameters for a system-wide definition of sustainable food production. For each of these, the Commission proposes boundaries that global food production should stay within to decrease the risk of irreversible and potentially catastrophic shifts in the Earth system. These planetary boundaries for food production conceptually define the upper limit of environmental effects for food production at the global scale."

Defining a Healthy Sustainable Diet

The report outlines how "unhealthy diets are the leading cause of ill health worldwide, with 800 million people currently hungry, 2 billion malnourished and a further 2 billion people overweight or obese". "The analysis shows that staying within the environmental safe operating space for food systems requires a combination of substantial shifts toward mostly plant-based dietary patterns, dramatic reductions in food losses and waste, and major improvements in food production practices." The transformation to healthy diets will require substantial dietary shifts which are presented in the **Planetary Health Plate**.

The Planetary Health Plate

"A planetary health plate should consist by volume of approximately half a plate of vegetables and fruits; the other half, displayed by contribution to calories, should consist of primarily whole grains, plant protein sources, unsaturated plant oils, and (optionally) modest amounts of animal sources of protein." EAT Lancet Commission Report, 2019.

The planetary health plate states that animal products have to be minimised or eliminated completely. Globally, these dietary recommendations require red meat and sugar consumption to be cut by half, while vegetables, fruit, pulses and nuts must double. North Americans need to eat 84% less red meat but six times more beans and lentils. Europeans should eat 77% less red meat and 15 times more nuts and seeds. The report does not advocate a vegan diet but clearly the more plant based a diet is the more ecologically sustainable it becomes. The report says the data are both sufficient and strong enough to warrant immediate action. "Delaying action will only increase the likelihood of serious, even disastrous, consequences." The impacts of these changes are enormous. The Commission analyzed the potential impacts of dietary change on diet-related disease mortality and concluded that dietary changes from current diets toward healthy diets are likely to result in major health benefits. This includes preventing approximately 11 million deaths per year, which represent between 19% and 24% of total deaths among adults.

IPCC Special Report on Global Warming of 1.5°C

In October 2018 the Intergovernmental Panel on Climate Change issued their Special Report on Global Warming of 1.5°C. The report shows how an increase of another 1.5°C would be detrimental to the planet's liveability, and that at the current rate of global warming we could exceed a 1.5°C increase in the next 12 years – by 2030. The report shows that the effects of 2°C of further warming would be far more serious. The report outlines the most serious impacts including impacts on coral reefs, sea-level changes, food shortages, livestock, water shortages, ecosystem changes and economic impacts, with disadvantaged populations being particularly at risk. In order to prevent these impacts the report calls for changes at the national level including:

- Massive reductions in the emissions of methane and black carbon (35% or more of both by 2050 relative to 2010), and a shift away from fossil fuels by mid-century, with coal phased out far sooner than previously suggested.
- Sustainable intensification of land use practices, ecosystem restoration and changes towards less resource-intensive diets. Vast tracts of land given over to forests.
- International cooperation between and within countries and communities, without making the poor and disadvantaged worse off.
- Rapid transitions in land, energy, industry, buildings, transport, and cities.

Recommended changes at the individual level include the following:- Buy less meat, milk, cheese and butter; buy more locally sourced seasonal food; throw less food away; drive electric cars but walk or cycle short distances; take trains and buses instead of planes; use video-conferencing instead of business travel; use a washing line instead of a tumble dryer; insulate homes; demand low carbon in every consumer product.

Reducing food's environmental impacts through producers and consumers. Authors: J. Poore, T. Nemecek, June, 2018.
"With current diets and production practices, feeding 7.6 billion people is degrading terrestrial and aquatic ecosystems, depleting water resources, and driving climate change..... More than 570 million farms produce in almost all the world's climates and soils, each using vastly different agronomic methods; average farm sizes vary from 0.5 hectares in Bangladesh to 3000 hectares in Australia; average mineral fertilizer use ranges from 1kg of nitrogen per hectare in Uganda to 300kg in China.....Food's environmental impacts are created by millions of diverse producers. To identify solutions that are effective under this heterogeneity, we consolidated data covering five environmental indicators; 38,700 farms; and 1,600 processors, packaging types, and retailers."

"Today's food supply chain creates 13.7 billion metric tons of CO_2eq, 26% of anthropogenic GHG emissions. A further 2.8 billion metric tons of CO_2eq (5%) are caused by nonfood agriculture and other drivers of deforestation. Food production creates 32% of global terrestrial acidification and 78% of eutrophication. These emissions can fundamentally alter the species composition of natural ecosystems, reducing biodiversity and ecological resilience. The farm stage dominates, representing 61% of food's GHG emissions (81% including deforestation), 79% of acidification, and 95% of eutrophication."

"Today's agricultural system is also incredibly resource intensive, covering 43% of the world's ice and desert-free land. Of this land, 87% is for food and 13% is for biofuels and textile crops or is allocated to nonfood uses such as wool and leather. Two-thirds of freshwater withdrawals are for irrigation. However, irrigation returns less water to rivers and groundwater than industrial and municipal uses and predominates in water-scarce areas and times of the year, driving 90-95% of global scarcity-weighted water use". The report calculated that "meat, aquaculture, eggs, and dairy use 83% of the world's farmland and contribute 56-58% of food's different emissions, but provide only.....18% of our calories".

"Today, and probably into the future, dietary change can deliver environmental benefits on a scale not achievable by producers. Moving from current diets to a diet that excludes animal products has transformative potential, reducing food's land use by 3.1 (2.8-3.3) billion hectares (a 76% reduction), including a 19% reduction in arable land; food's GHG emissions by 6.6 (5.5-7.4) billion metric tons of CO_2eq (a 49% reduction); acidification by 50% (45-54%); eutrophication by 49% (37-56%); and scarcity-weighted freshwater withdrawals by 19% (−5 to 32%) for a 2010 reference year. For the United States, where per capita meat consumption is three times the global average, dietary change has the potential for a far greater effect on food's different emissions, reducing them by 61-73%."

"Further, lowering consumption of more discretionary products (oils, sugar, alcohol, and stimulants) by 20%.....reduces the land use of these products by 39% on average. For emissions, the reductions are 31 to 46%, and for scarcity-weighted freshwater withdrawals, 87%. Communicating average product impacts to consumers enables dietary change and should be pursued."

"At present, it's better to change what you consume, rather than trying to purchase sustainable animal products. So plant-based diets are the best way to reduce food's impacts," Joseph Poore of the Department of Zoology and the School of Geography and Environment, Oxford University, and co-author of the study published in Science, told Newsweek. He also highlighted that **food is not just an issue for greenhouse gas emissions but causes almost all of the world's major environmental issues.**

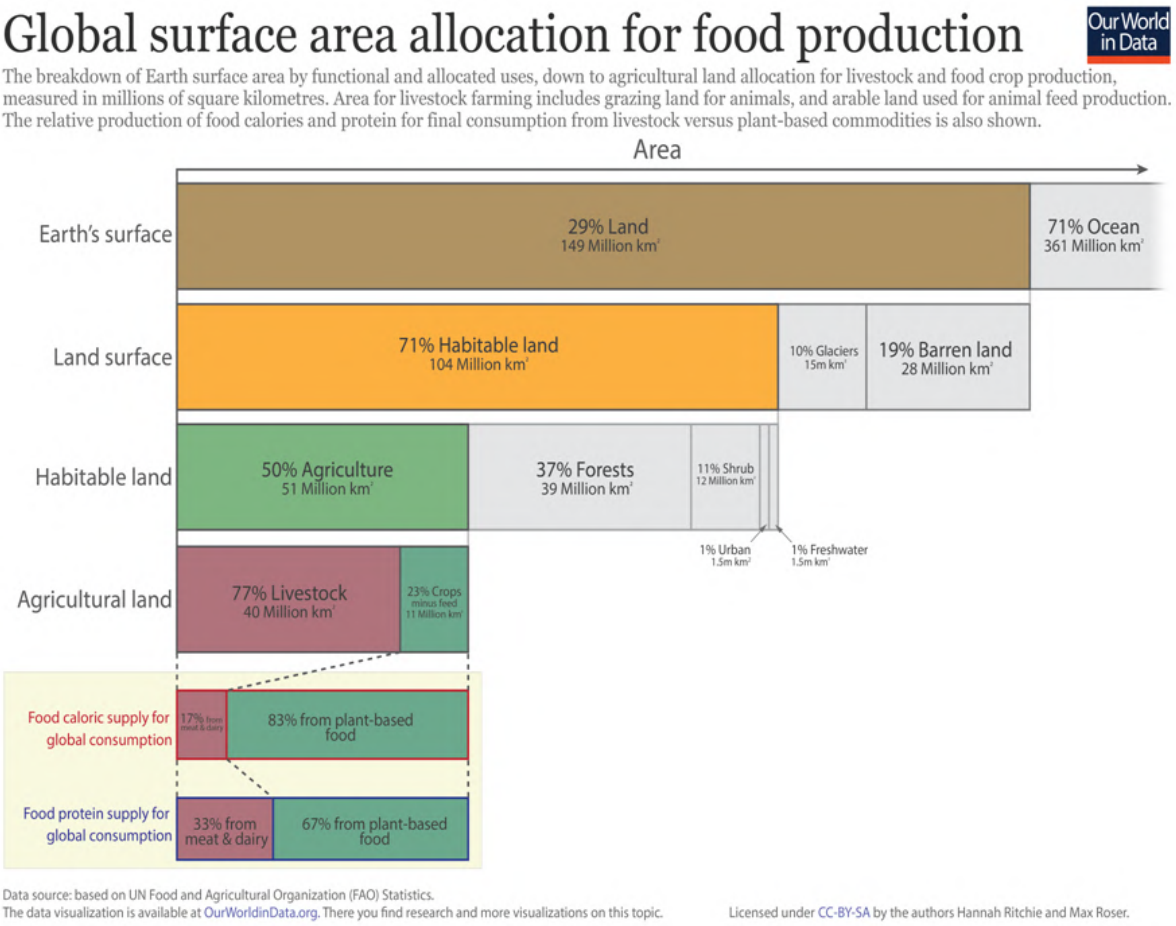
Chapter 3:

Land use and Biodiversity Impacts

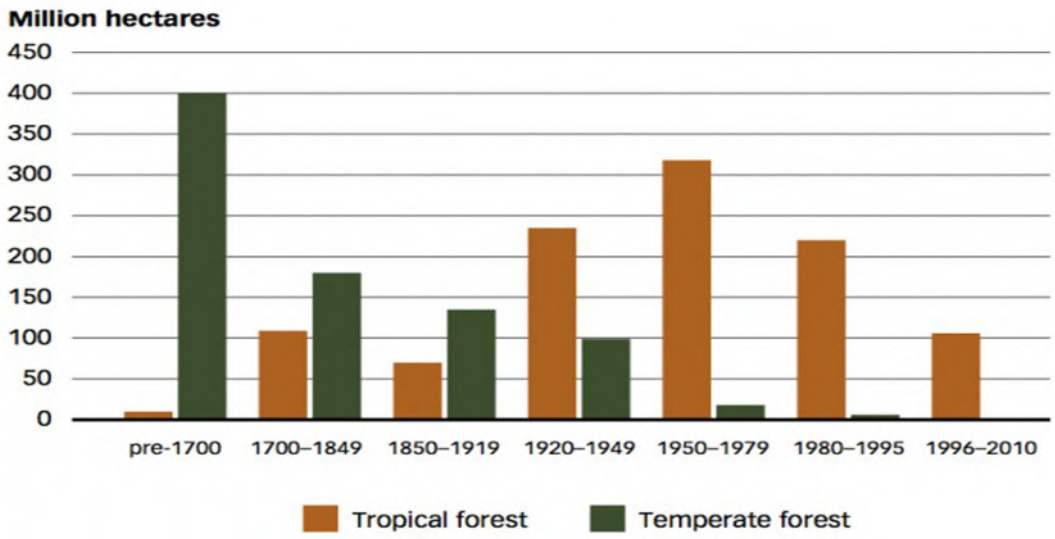
Chapter 3:
Land Use and Biodiversity Impacts

3.1 Global, EU and Irish Agricultural Land Use

Globally Land Use is totally dominated by agriculture as shown in the below image.



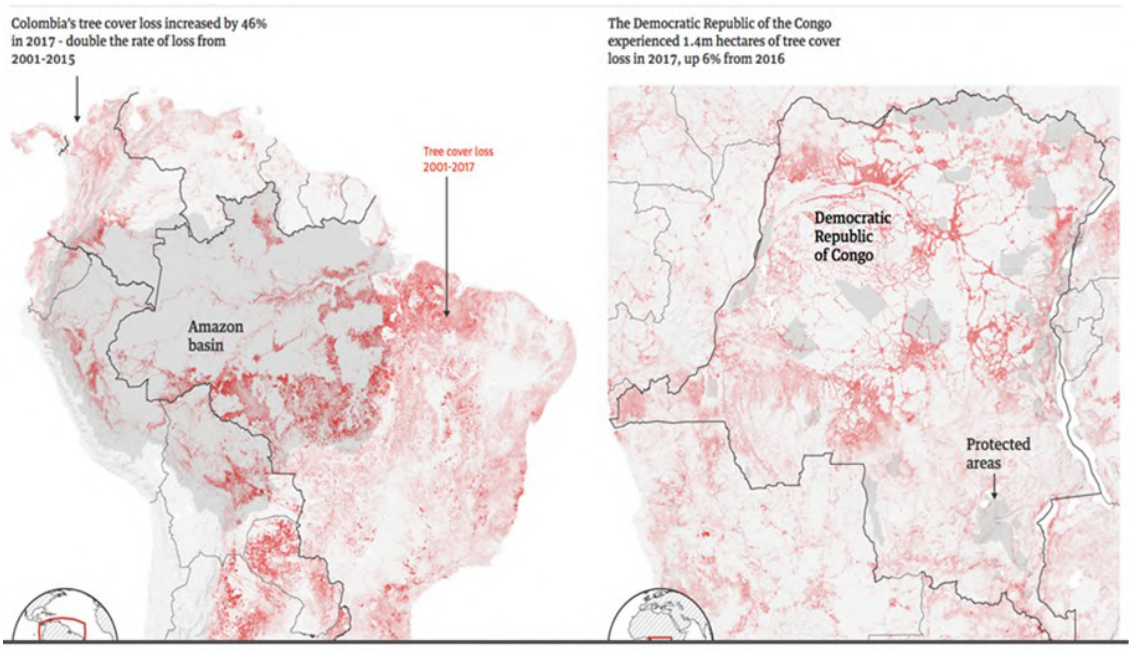
The below diagram shows the scale and timing of deforestation in temperate and tropical regions. Approx. 20 million Km² of forests have been cut down for agriculture.



In 2017 the world lost more than one football pitch of forest every second adding up to an area equivalent to the whole of Italy over the year. The scale of forest destruction, much of it done illegally, poses a grave threat to tackling both climate change and the massive global decline in wildlife. The loss in 2017 recorded by Global Forest Watch was 29.4m hectares, the second highest recorded since the monitoring began in 2001. This is what it looks like:

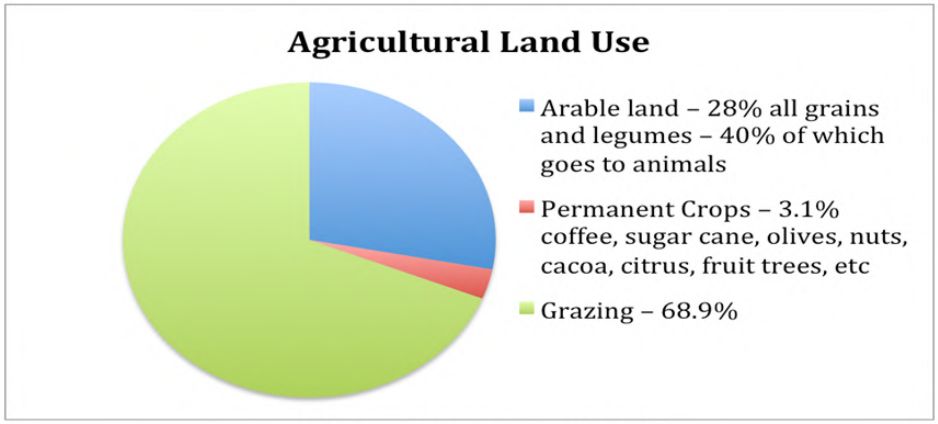
2017 Conversion of forests to soy monoculture, Argentina. Photo: Jim Wickens, Ecostorm

This is what it looks like on a map:



Global Forest Watch, 2018

Only 1% of the planet's land area is built up areas (towns, cities, etc.) while 50% of the habitable land is agriculture. Globally 77–83% of agricultural land is used for animal agriculture. This includes grazing land and crops grown for animal feed.



Vegan Sustainability Magazine (Data Source: FAO)

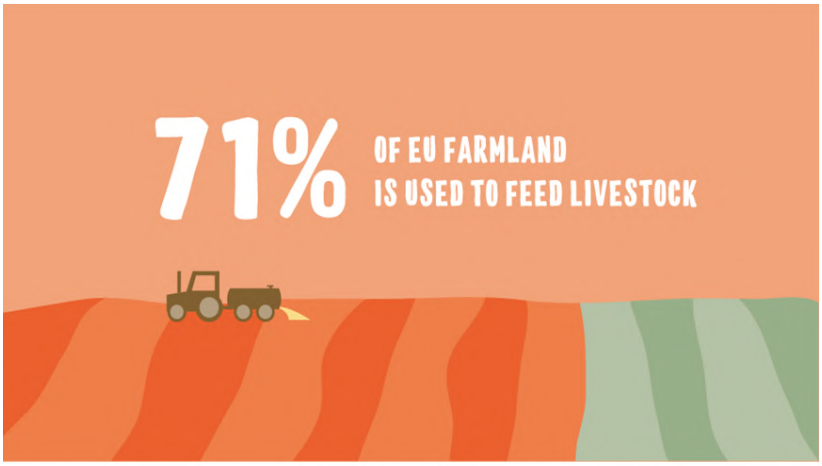
"The Industrial Food Chain uses at least **75%** of the world's agricultural resources but provides food to less than **30% of the world's people."** – Who will feed us?, 2017 GRAIN.

An average of 42% of land in Europe is used for agriculture. According to a 2019 Greenpeace Report, "over 71% of all the EU agricultural land (land used to grow crops – arable land – as well as grassland for grazing or fodder production) is dedicated to feeding livestock".

"When excluding grasslands, and only taking into account land used for growing crops, we see that over 63% of arable land is used to produce animal feed instead of food for people." The Report continues: "Using land to grow feed for livestock is a highly inefficient use of natural resources, whether in Europe or elsewhere. Animals are able to convert only between 10 - 30% of the feed they consume into food for people with significant consequences for the amount of land needed."

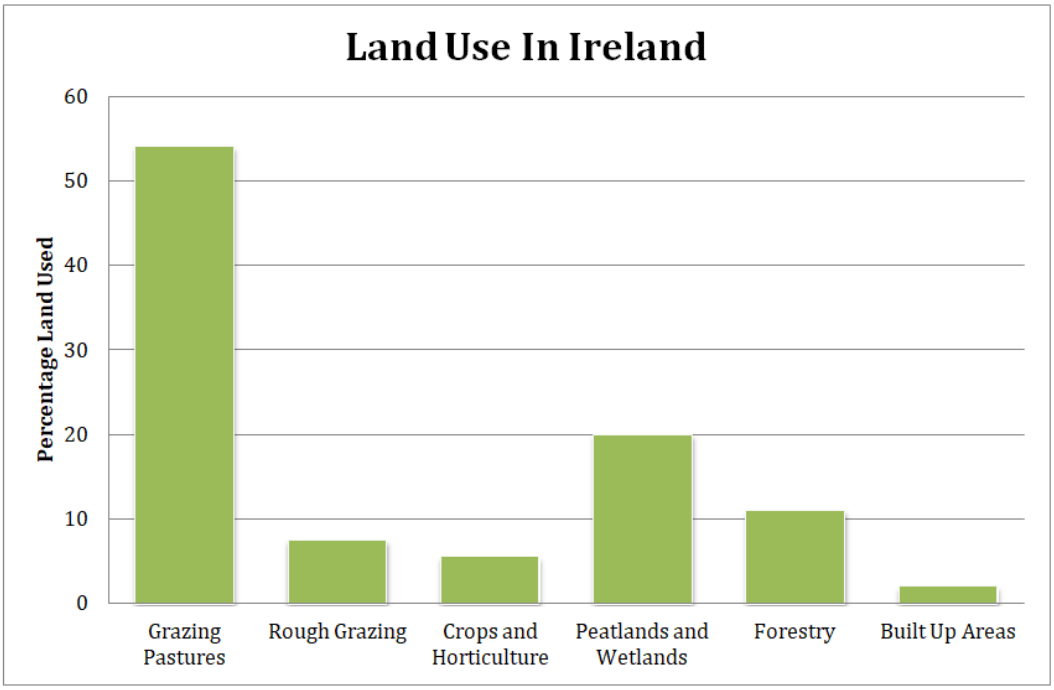
According to the CSO Environmental Indicators Webpage and the CSO 2016 Farm Structure Survey (FSS) there was almost 4.9 Mha of Agricultural Area Used (AAU) in Ireland in 2016. Grassland occupied 4.1 Mha and 0.43 Mha was Commonage, with another 16,300 ha of Rough Grazing. Cereals occupied 0.28 Mha, and Other Crops, Fruit and Horticulture 71,100 ha.

Ireland's agriculture occupies 70% of the land. Peat and wetlands occupy 16%, and forestry 11%. Together these occupy 97% of Ireland's land. Built up areas in Ireland occupy under 2%. The European average for agricultural land use is 42% and for forestry is 34%. Ireland's ecosystems are dominated by the extractive industries of agriculture, peat extraction and monoculture forestry. According to an EPA 2016 Report only 7% of land based ecosystems are considered to be in a favourable ecological condition.



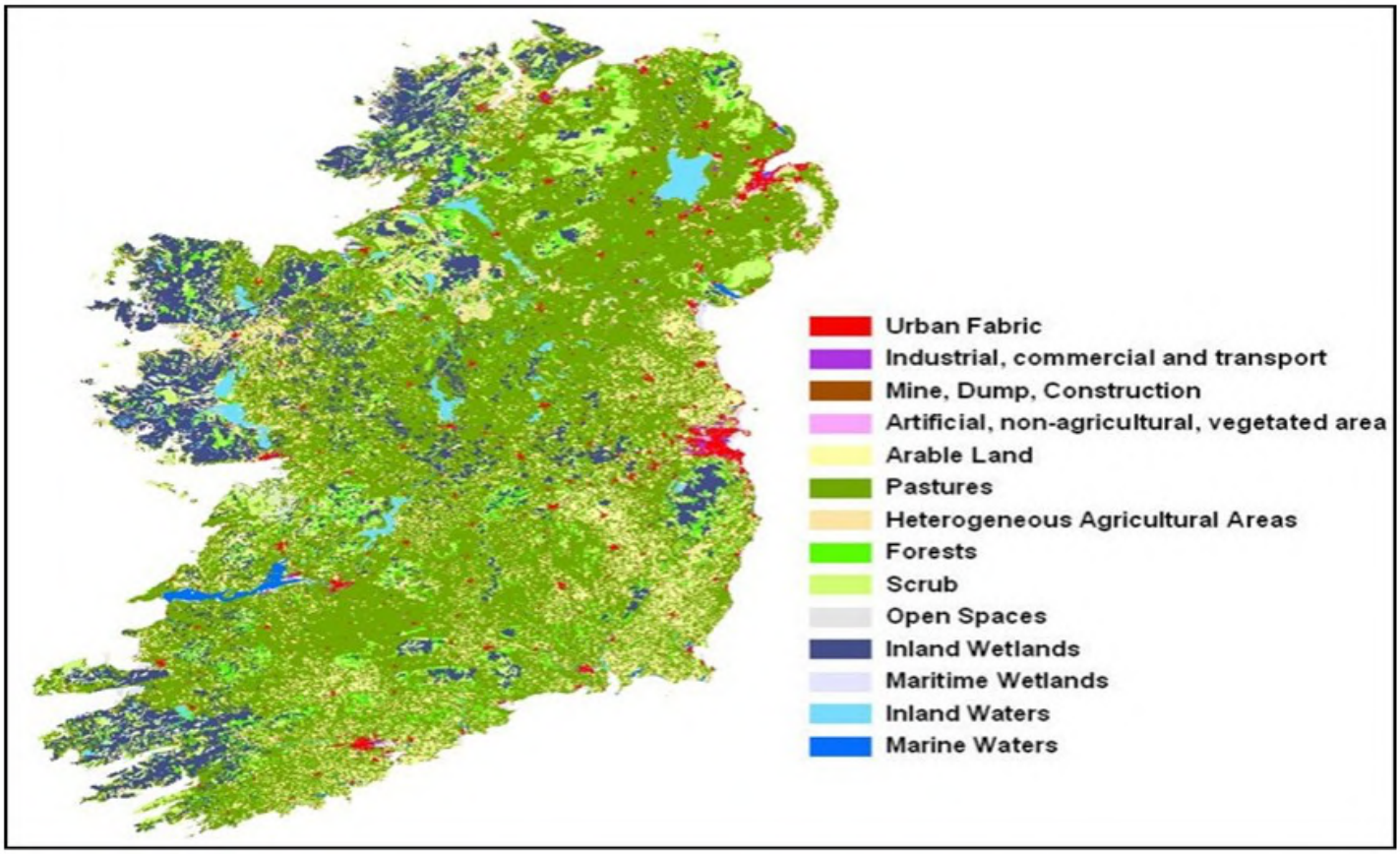
Greenpeace, 2019

Type of Land Use	Percentage Land Used	Percentage Land Used
Grazing Pastures	54%	Agriculture Total 67%
Rough Grazing	7.5%	
Crops and Horticulture	5.5%	
Peatlands and Wetlands	20%	20%
Forestry	11%	11%
All Built Up Areas	2%	2%



Vegan Sustainability Magazine (Data Source: EU Commission)

Breaking down the total agricultural land area we find that 84% of the agricultural area is devoted to pasture, hay and grass silage (4.1 Mha), 9% to commonage and rough grazing (0.45 Mha), 6% for cereals (0.28 Mha), and 1.4% for other crops, fruit & horticulture production (0.07 Mha) to give a total of 4.9 Mha. The majority of the cereals are produced for animal feed. In total, **97% of Ireland's agricultural land is used for the production of meat and dairy products.**



Dwyer, 2013

3.2 A Brief History of Irish Agricultural Land Use

Europe is losing its farms. Between 2005 and 2013, 3.7 million farms ceased to exist, a drop of 26% (from 14.4 million to 10.7 million). The proportional loss of livestock farms was even more pronounced, falling by 32%, from 9 million to 6.1 million, in the same time-frame. While the number of farms is decreasing, their size follows the opposite trend. Almost three quarters of the live-stock units (72.2%) in the EU-28 were reared on very large farms in 2013. In Ireland from 1991 to 2016 there was a drop of 33,100 farms (19% in 25 years) leaving 137,500 farms in 2016. Overall since 1855 there has been a loss of 282,000 farms as people have moved off the land to try to take advantage of better economic opportunities – at times voluntarily, but often people were forced off by poverty. The average farm size gradually increased as the land was absorbed into other farms and some developed for-estry. Ireland's agricultural land area has decreased from a maxi-mum of 5.25 Mha in 1872 to today's agricultural land area of 4.5 Mha. Over the same period the area of forestry increased from approx. 0.07 Mha to 0.77 Mha. The area of land converted from native ecosystems has remained fairly constant at 5.3 Mha over the past 170 years – 78% of the land area.

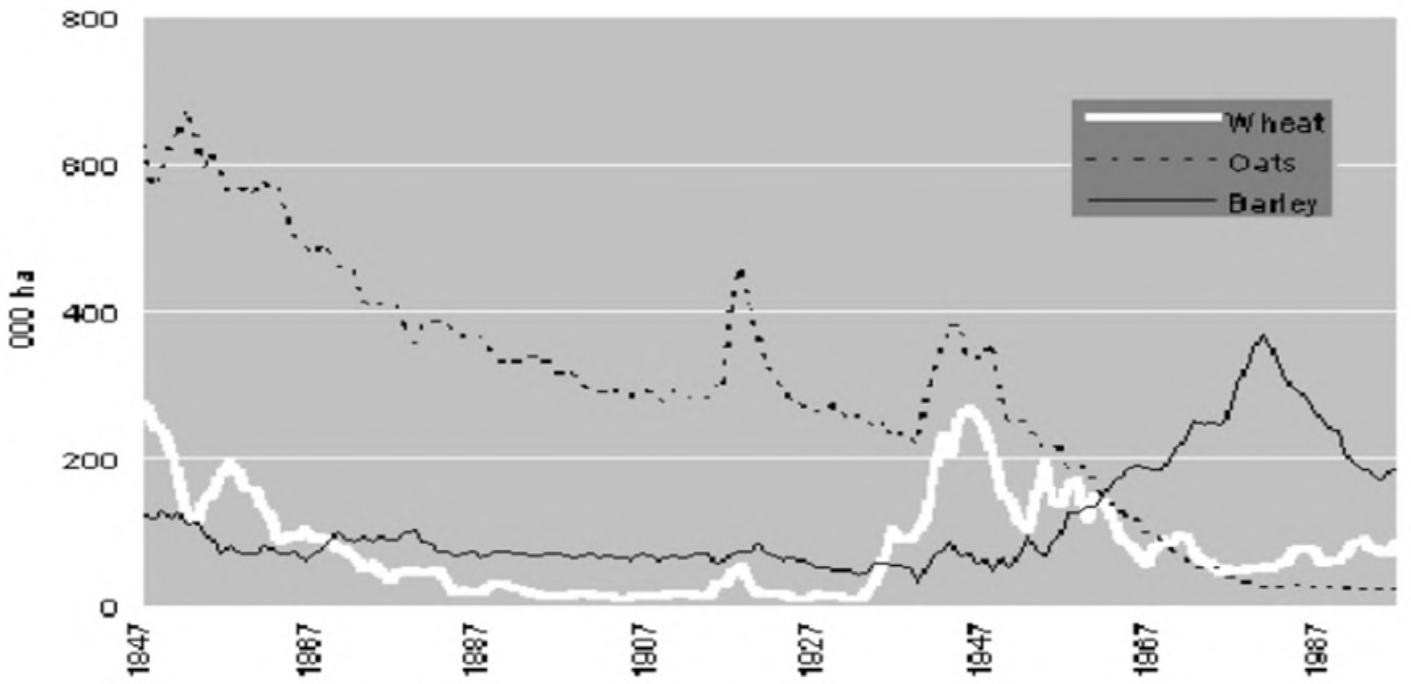
The Area under Tillage has dropped by 75%

Since 1847 there has been a dramatic decline in the area under crops, fruit and horticulture with the 1996 estimate comprising only 26% of the 1851 area. The below table makes it very clear that historically Ireland's farmers have succeeded in growing grains, legumes and vegetables on a large scale. From this it can be reasonably concluded that Ireland's land and climate is very suitable for a plant based agricultural system.

Category	Maximum		Minimum	
	Year	000 ha	Year	000 ha
Corn crops	1847	1,026	1994	276
Wheat	1847	272	1931	8
Oats	1852	672	1995	20
Barley	1980	366	1939	30
Root and green crops	1859	520	1991	79
Potatoes	1859	374	1991	20
Turnips	1853	128	1993	5
Sugar beet	1987	37	1931	2
Flax	1864	38	1958	0
Crops, fruit and horticulture	1851	1,420	1991	392
Hay and pasture	1905	4,416	1991	3,408
Crops and pasture	1872	5,250	1991	3,800

Farming since the Famine, Irish Farming Statistics from 1847 – 1996: CSO

The below diagram shows how the area planted with oats, wheat and barley has changed over the years, at times very rapidly due to political or government agricultural policy changes relating in particular to farm payments and price supports such as import restrictions.



Farming since the Famine, Irish Farming Statistics from 1847 – 1996: CSO

"The substantial recovery from 1932 to 1933 in the area under corn crops (oats, wheat and barley) was a direct result of legislation (Agricultural Produce (Cereals) Act) in 1933, which provided for a bounty on home-grown millable wheat to bring the price up to a fixed price per barrel. Restrictions were at the same time imposed on the importation of wheat, maize and certain feeding stuffs. Provision was made for a proportion of home-grown wheat to be used in the production of wheat-meal and flour."

"The long-term decline in tillage is associated more with oats than with any other crop. The highest recorded acreage was 672 Thousand ha (kha) in 1852. This was followed by a steady decline until World War One when 294 kha were sown. The 1920s and 1930s saw further contraction before some expansion during World War Two. Following the second World War, the long term decline in oats resumed and continued, largely uninterrupted, to reach 25 kha in 1980. Since 1980 the area sown has stabilised around 20 kha or less than 4% of the peak area sown in 1852." – Farming since the Famine, Irish Farming Statistics from 1847 – 1996.

Significant Increase in Crop Yields

The yield per hectare has substantially increased for all crops since the 1950s with the introduction of fertilisers and mechanisation. Below are the yields in 1916 and 2014.

Crop	1916			2014		
	Area (Hectares)	Yield (tons)	Yield (tons per hectare)	Area (Hectares)	Yield (tons)	Yield (tons per hectare)
Wheat	26,000	76,961	3	71,600	717,000	10
Oats	294,000	905,317	3	18,600	150,000	8
Barley	60,000	142,374	2	216,000	1,731,000	8
Potatoes	172,000	2,443,346	14	9,500	383,000	41

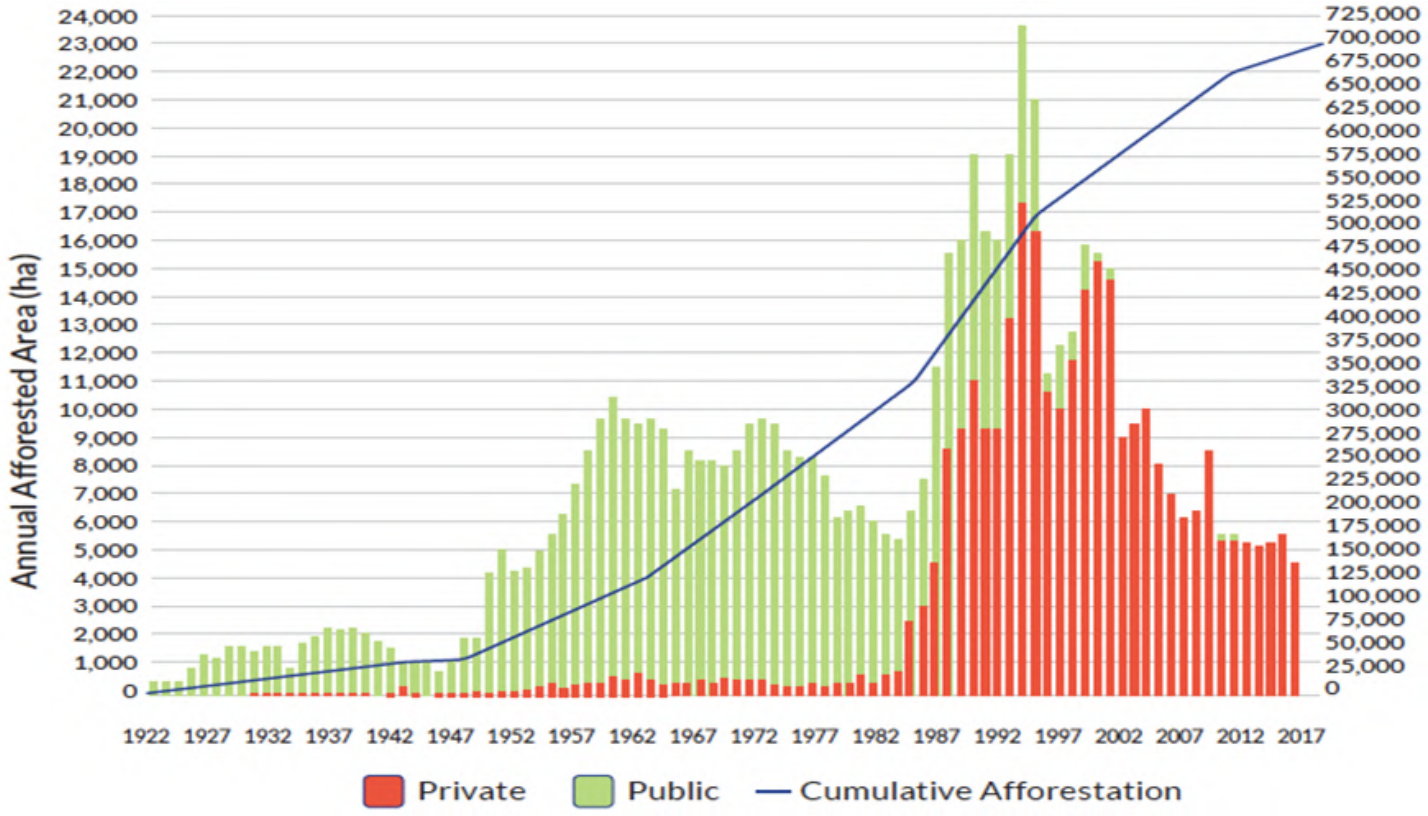
Source: Agriculture Statistics Ireland 1916, and Area, yield and production of Crops: CSO

3.3 A Brief History and Outlook of Irish Commercial Forestry

At the EU level, the Forest Europe 2015 Report states that the area of forest amounts to 215 Mha, accounting for 34% of total land area. In comparison to other regions in the world, only South America has a higher percentage of forest cover (49%). 45% of European forests are predominantly coniferous, 36% are predominantly broadleaved, and the rest are mixed, while around 80% of the forest area is available for wood supply. The report notes that the forest land area has continuously increased since 1990.

'Irish Forests: A Brief History', by the Forest Service, Department of Agriculture, Fisheries and Food, 2008 tells the story of how Ireland lost its forests over the last 7,000 years. By the start of the first millennium AD much of Ireland was still covered with forest. As the population increased over the following centuries, the demand for timber also increased and the exploitation intensified under the Anglo-Normans and, later, successive English monarchs. Nevertheless, there were extensive forests in Ireland before 1600. However, these forests were largely gone by 1800.

"The area of forest is estimated to be 770,020 (ha) or 11.0% of the total land area of Ireland (National Forest Inventory 2017). Of the total forest area, nearly 391,358 ha or 50.8% is in public ownership, mainly Coillte, with over 21,000 individual forest owners with forest holdings averaging just 8.8 hectares. The forest estate is comprised of three quarters conifers and one quarter broadleaves. Nearly half of the stocked forest area is less than 20 years of age. The promotion of afforestation and the mobilisation of the private timber resource continue to be key objectives of DAFM. Forestry rural employment is c. 12,000 jobs.



Department of Agriculture Annual Review and Outlook, 2018

Afforestation peaked in 1995, when 17,353 hectares were planted. Combined with 6,367 hectares planted by Coillte Teoranta in that year, 1995 saw the highest level of afforestation (23,710 hectares) ever achieved in the country in a single year." In 2017, €93.6 million of capital expenditure was invested in forestry development in Ireland, 93% of which went towards afforestation grants and premiums. An additional €5.88 million was spent on other forestry support schemes for forestry and woodland reconstitution and development projects. **Over 80% of Ireland's forest products are exported. According to the DAFM, "**In 2016, over 1.5 million tonnes of forest based biomass was used for energy purposes in Ireland; this helped to avoid an estimated 761,000 tonnes of CO_2 from fossil fuel use." But what they don't say is that wood produces more than double the GHG emissions per unit heat energy generated than any fossil fuel including coal.

Forestry 2030 charts a way forward for the Irish forestry sector. Higher grant and premium rates have been introduced to encourage more broadleaf and diverse conifer planting. The minimum mandatory requirement per site has been increased from 10% to 15% broadleaves. According to the DAFM: "Maintaining the climate change benefits of Irish forests will require continuation of the national afforestation programme at a rate exceeding 15,000 hectares per annum over the next two decades. Under 5,000 ha was afforested in 2017." It's clear that these goals will be completely inadequate to reverse biodiversity loss and contribute to Ireland reducing its GHG emissions. Because with 85% monoculture conifers you have 85% of the land with nearly complete biodiversity loss. The state owned Coillte has returned a mere €40 million euro to its shareholders (the Government) since its establishment 30 years ago – not taking into account around €150 million dished out in grants and support.

3.4 Biodiversity Impacts of Land Use

In May 2019 the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services released the Global Assessment Report on Biodiversity and Ecosystem Services. The report was clear in its assessment of how human beings have already impacted biodiversity and ecosystem. "Nature across most of the globe has now been significantly altered by multiple human drivers, with the great majority of indicators of ecosystems and biodiversity showing rapid decline. Seventy-five per cent of the land surface is significantly altered, 66 per cent of the ocean area is experiencing increasing cumulative impacts, and over 85 per cent of wetlands have been lost.....Human actions threaten more species with global extinction now than ever before. **An average of around 25 per cent of species in assessed animal and plant groups are threatened, suggesting that around 1 million species (from a total of 8 million species) already face extinction**, many within decades, unless action is taken to reduce the intensity of drivers of biodiversity loss. Without such action there will be a further acceleration in the global rate of species extinction, which is already at least tens to hundreds of times higher than it has averaged over the past 10 million years.....These declines will also undermine other goals, such as those specified in the Paris Agreement adopted under the United Nations Framework Convention on Climate Change and the 2050 Vision for Biodiversity." The main drivers outlined in the report are agriculture, fishing and hunting and trade in wildlife.

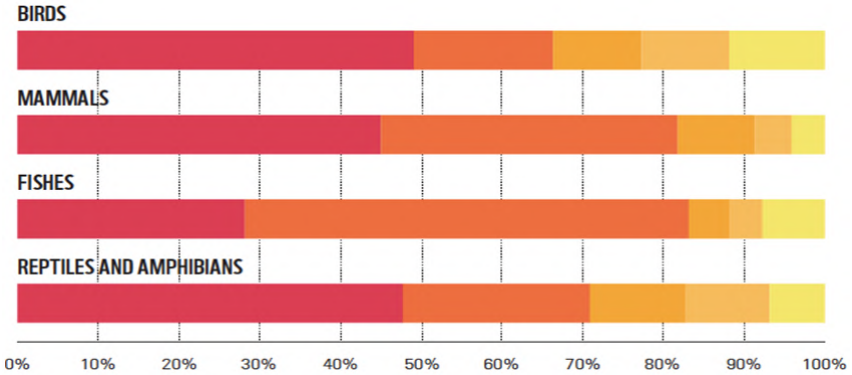
The Living Planet Index (LPI) is a population biodiversity indicator. It tracks the state of global biodiversity by measuring the population abundance of thousands of vertebrate species globally. Living Planet Indices show the average rate of change over time across a set of species populations. These populations are taken from the Living Planet Database, which now contains information on more than 22,000 populations of mammals, birds, fish, reptiles and amphibians. The latest index shows an overall decline of 60% in population sizes between 1970 and 2014. A 60% decline in the human population would be equivalent to emptying North America, South America, Africa, Europe, China and Oceania.

What are the Threats and Underlying Drivers of Biodiversity Loss for Vertebrates?

In a recent paper, researchers writing in the journal *Nature* analysed the most prevalent threats facing more than 8,500 threatened or near-threatened species on the International Union for Conservation of Nature (IUCN) Red List. They found that the key drivers of biodiversity decline remain agriculture and overexploitation. Indeed, of all the plant, amphibian, reptile, bird and mammal species that have gone extinct since AD 1500, 75% were harmed by agricultural activity or overexploitation or both. According to the IUCN Red List data, whatever the threat category or the species group, agriculture and overexploitation (fishing and hunting) are the 'big killers' with the greatest current impact on biodiversity.

Information about threats is available for just over a quarter of all species records in the global Worldwide Fund for Nature (WWF) Living Planet Index – 3,789 populations. These threats are grouped under five major categories: habitat degradation and loss (agriculture, logging, and fishing), overexploitation (fishing, hunting, species trade), invasive species and disease, pollution, and climate change.

Key	Underlying Driver/Cause
Habitat degradation/ loss	Agriculture, Fishing and logging
Exploitation	Fishing & Hunting
Invasive species and disease	Zoonotic disease, pesticides, opportunistic diseases.
Pollution	Agriculture, Energy, Industry, Transport
Climate change	Agriculture, Energy, Industry, Transport



What are the Global Causes of Biodiversity Loss for Invertebrates?

97% of the Animal Kingdom consists of invertebrates such as insects, crabs, lobsters, clams, octopuses, jellyfish, and worms, etc. In the past couple of years a number of studies have been released showing major declines in invertebrate populations. A Stanford University global index developed by Rodolfo Dirzo showed a 45% decline for invertebrates over four decades. Of 3,623 terrestrial invertebrate species on the IUCN Red List, 42% are classified as threatened with extinction. One of the world's best and oldest entomological resources is the German Krefeld Entomological Society (est. 1905) tracking insect abundance at more than 100 nature reserves. They first noticed a significant drop off of insects in 2013 when the total mass of catch fell by 80%. Again, in 2014 the numbers were just as low. Subsequently, the society discovered huge declines in several observation sites throughout Western Europe. For example, Krefeld data for hoverflies, a pollinator often mistaken for a bee, registered 17,291 hoverflies from 143 species trapped in a reserve in 1989. Whereas by 2014 at the same location, 2,737 individuals from 104 species, down 84%. (Source: Gretchen Vogel, Where Have All The Insects Gone? Science Magazine, May 10, 2017). A recent analysis, published in the journal Biological Conservation, says intensive agriculture is the main driver, particularly the heavy use of pesticides.

Ireland's Biodiversity

Land use changes from native forests and ecosystems to agricultural land and monoculture forests are also the main driver of biodiversity loss in Ireland and together they occupy 81% of the land. Exploitation of peatlands for fuel has been under way in Ireland for 400 years. According to the Irish Peatland Conservation Council: "Today traditional turf cutting, mechanical turf cutting and industrial peat extraction have accounted for a staggering loss of 47% of the original area of peatlands in Ireland. This represents over half a million hectares of land." Overall about 89% of the ecosystems in Ireland have been completely altered and the biodiversity eliminated. The below images show what it looks like when you move from a native forest to a commercial monoculture forest.

Data Mining for Biodiversity Prediction in Forests, UCC 2008

And a native grassland to an intensive monoculture grassland:

http://wildflowers.ie/

Teagasc, Managing your Grass (accessed May, 2019)

Monoculture grasslands with a scattering of monoculture forests, mostly on higher ground, dominate the Irish Landscape.

Screenshot from Google Maps

This is why Ireland has one of the lowest Biodiversity Intactness Indexes in the world.

From the RSPB State of Nature UK Report, 2016 – Ireland appears to be ranked 203 out of 218

The basis for land use management in Ireland, with the associated habitat and biodiversity loss, is the Common Agricultural Policy as administered by the Department of Agriculture. Under the EU Basic Payment Scheme 2017 the Terms and Conditions of receiving payment currently states the following: "In the case of each hectare declared, the eligible area excludes any areas under roads, paths, buildings, farmyards, **woods, scrub,** rivers, streams, ponds, lakes, sand, areas of bare rock, **boglands unfit for grazing,** sand/gravel pits, areas used for quarrying, areas fenced off and not being accessed, **areas ungrazed due to low stocking rates, areas of ungrazed mature heather, rushes or ferns, inaccessible areas, land that is not being maintained in a state suitable for grazing or cultivation by the farmer,** areas used exclusively as sports fields, golf courses, pitch and putt courses, areas used for commercial turf production or any other areas of ungrazable groundcover. Deductions are not required for headlands or for landscape features such as hedgerows and drains/ditches." If any farmer wants to receive an income they are obliged to convert all available land to monoculture grazing land by draining, clearing and burning and spraying pesticides and herbicides on everything that would make their land ineligible and therefore reduce their payments. So critical habitat is continually being whittled away. And the predictable result is that Ireland has one of the lowest levels of biodiversity intactness in the world.

Ireland Lacks Protected Areas

Ireland also has a poor history of establishing nature reserves. Ireland has the smallest area designated as a Special Protected Area (3%) under the EU Birds Directive. The EU average is 11.4%. 90% of designated Natura 2000 water dependent habitats have an unfavourable conservation status and 50% of Natura 2000 water dependent species have an unfavourable status. As of 2010, Ireland has 10.7% of its land area designated as a Special Area of Conservation under the EU Habitats Directive. This was the ninth smallest proportion of land area in the EU. The EU average was 13.7%. Unfortunately in Ireland these lands are not yet given legally binding protection. Ireland is failing to meet the strict legal obligations that the EU Habitats Directive places on member states to ensure the protection, conservation and management of the habitats and species of conservation interest in all EU sites. In Ireland only 7% of listed habitats are considered to be in a favourable state (EPA, 2016). Land used for organic farming accounted for 1.2% of total agricultural land in 2009 – the third smallest percentage of agricultural land given over to organic farming in the EU. Austria, with 18.5%, had the highest percentage of agricultural land farmed organically.

A Photo of their farm before the transition shows land management practices creating an appearance common in Ireland and across Europe. (Isabella Tree)

Soil Health

Soil is a living ecosystem, essential for human and environmental health. It is a vital, limited, non-renewable and irreplaceable resource for current and future generations. Soil is a biological engine where micro-organisms play a fundamental role in the decomposition of organic matter into nutrients available for plants, animals and humans. Together with larger organisms, such as earthworms, they contribute to the structure of the soil making it more permeable to water and gases which is very important in recharging surface and ground water resources and preventing flooding. Besides providing a habitat for the below-ground biodiversity, soil is essential for the survival of most above-ground species. Chemical pollution by fertilizers, pesticides, and antibiotics can destabilize the population dynamics of soil organisms, by affecting their reproduction, growth and survival.

3.5 Ecological Restoration – A Case Study

The key to reversing biodiversity loss from agriculture is Ecological Restoration. In 2001 the owners of Knepp Castle Estate, just 45 miles from Central London decided to give up intensive farming on their 3,500 acres. It was a difficult, but unavoidable, decision; on desperately poor soil – heavy clay – they rarely made a profit and had worked up an eye-watering overdraft. Gradually nature started to return to the fields. One very important point in this project is pointed out here by the author: "The key to Knepp's extraordinary success? It's about surrendering all preconceptions, and simply observing what happens. By contrast, conventional conservation tends to be about targets and control, and often involves micro-managing a habitat for the perceived benefit of several chosen species." They were also no longer willing to use the pesticides, fungicides and artificial fertilisers that had once seemed so essential.

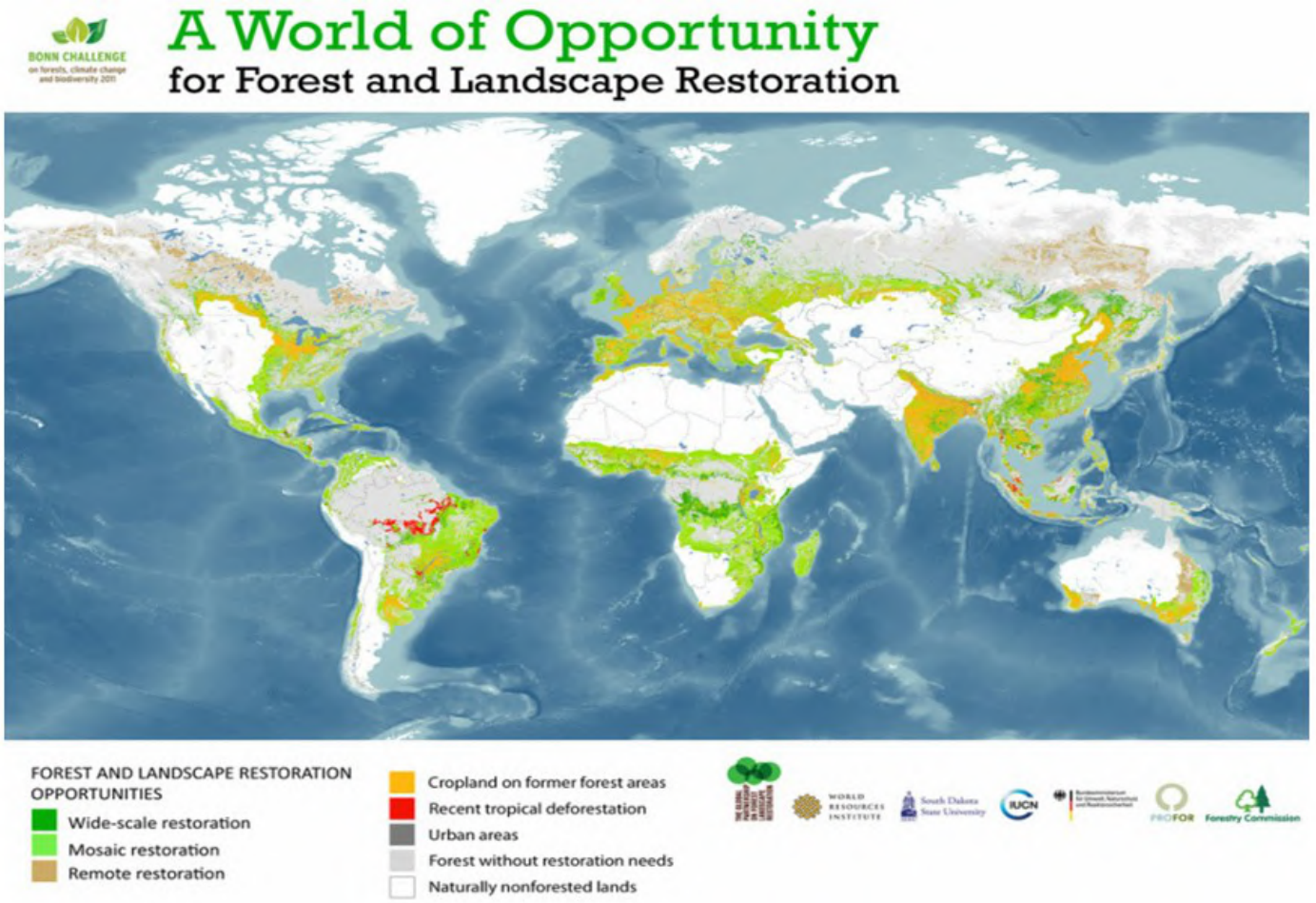
Thorny scrub – hawthorn, blackthorn, dog rose and bramble appeared in fields which, only a few years earlier, were blanketed with maize and barley. "Miles of hedgerows, previously cut back every autumn – thereby depriving birds of winter berries – have exploded into the welcoming earth, billowing out like a dowager liberated from her stays."

"The first thing that strikes visitors is the noise: the low-level surround-sound thrumming of insects. Then the countless different bird songs: the very air, it seems, is being recolonised with the sounds of the past. We walk knee-deep through ox-eye daisies, bird's-foot trefoil, ragged robin, knapweed, red clover, lady's bedstraw, crested dog's tail and sweet vernal grass, kicking up grasshoppers, hoverflies and all sorts of bumblebees. On a good July day, I can count ten species of butterfly — we have 34 altogether, including the rare purple emperor — without moving from my desk. At night, Knepp hosts an incredible 441 different species of moth. Meanwhile, more and more endangered species turn up every year — such as turtle doves, which are on the brink of extinction, and nightingales, whose numbers fell by 91 per cent between 1967 and 2007. Cuckoos, spotted flycatchers, fieldfares, hobbies, woodlarks, skylarks, lapwings, house sparrows, lesser spotted woodpeckers, yellowhammers, woodcock, red kites, sparrowhawks, peregrine falcons, all five types of British owl, the first ravens at Knepp in the past 100 years — the list goes on and on. The speed at which all these species — and many more — have appeared has astonished observers, particularly as our intensively farmed land was, biologically speaking, in dire condition at the start of the project." – Extracts from Wilding: The Return of Nature to a British Farm, by Isabella Tree.

Conclusion

A VAS allows us to restore our ecosystems and biodiversity, reverse climate change and still more than feed the world's population. This is the key step to addressing so many of the environmental issues we have today on a global and local level.

Photo of the same patch of land a number of years into the project. (Isabella Tree)



"Without meat and dairy consumption, global farm land use **could be reduced by more than 75%** – an area equivalent to the US, China, EU and Australia combined – **and still feed the world**." – Reducing food's environmental impacts through producers and consumers: J. Poore, T. Nemecek, June, 2018.

But first lets examine the economic, food security, climate change and health benefits of a VAS so that we can be sure that the benefits will be shared by rural and urban populations.

Chapter 4:

Water use and Biodiversity Impacts

Chapter 4:
Water Use and Biodiversity Impacts

This section describes the impacts of agriculture on Ireland's streams, rivers, lakes and drinking water. Industrial livestock production contributes heavily to water pollution with over 80% of EU agricultural nitrogen emissions to water linked to livestock. According to the European Nitrogen Report, nitrogen pollution costs the European Union from €70 to €320 billion a year. Nitrogen pollution of water potentially exposes an estimated 18 million people to drinking water with nitrate concentrations above recommended levels.

4.1 Water Quality Impacts

The regulations that govern water quality in Europe are outlined in the EU Water Framework Directive (WFD) which requires all waters in the state to acheive Good Environmental Status (GES). In order to meet its obligations under the WFD the Irish government has implemented a national catchment management approach to protect and improve Ireland's Water Bodies. Ireland is legally obliged to assign a status to all the water bodies and to monitor how the status changes in time.

The below map shows the current status of Ireland's water bodies (rivers, lakes, estuaries, etc.). Blue indicates High Status Sites and Green indicates GES. Over 50% of estuaries, lakes and rivers are failing to meet GES.

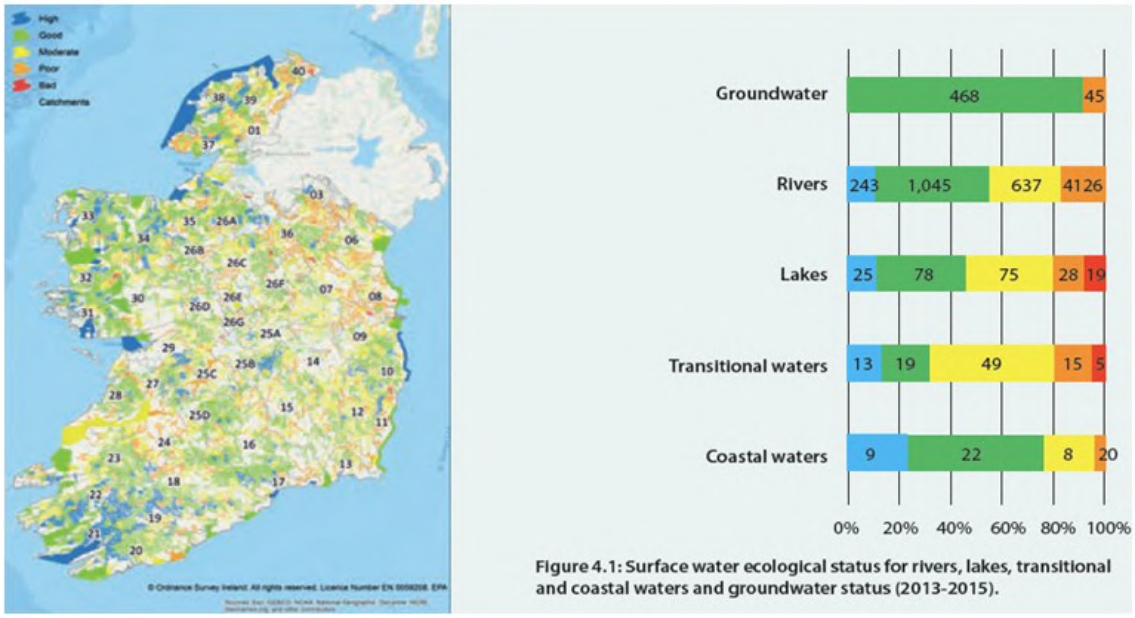


Figure 4.1: Surface water ecological status for rivers, lakes, transitional and coastal waters and groundwater status (2013-2015).

from Ireland's River Basin Management Plan (RBMP)

In order to determine the status of all the water bodies and to decide where to intervene to improve the water bodies the EPA undertook a catchment characterisation process. This identified 1,134 water bodies that were at risk of not meeting GES. The EPA then measured the different pressures on these water bodies (there is often more than one presssure). Agriculture was identified as by far the leading cause of the deterioration of Ireland's water bodies and a significant pressure in 64% of 'at risk' waterbodies as shown below.

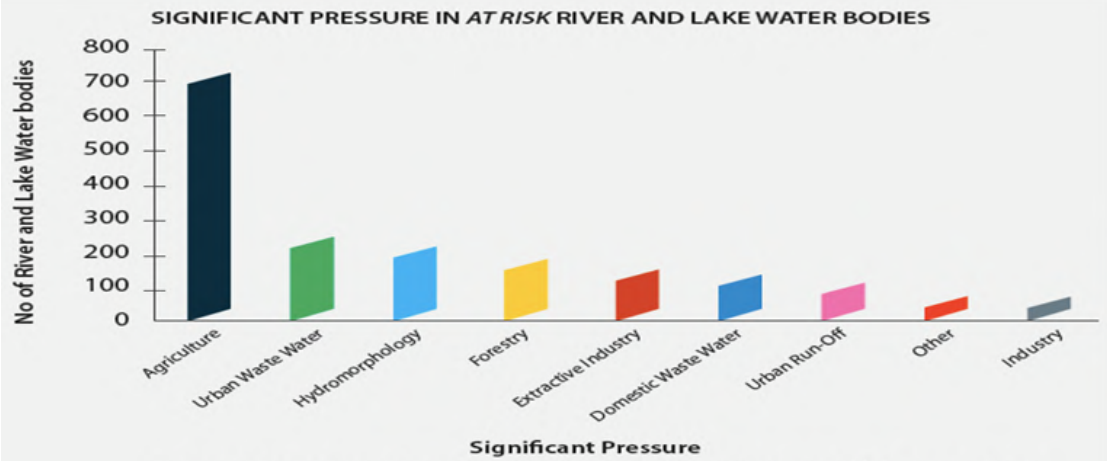
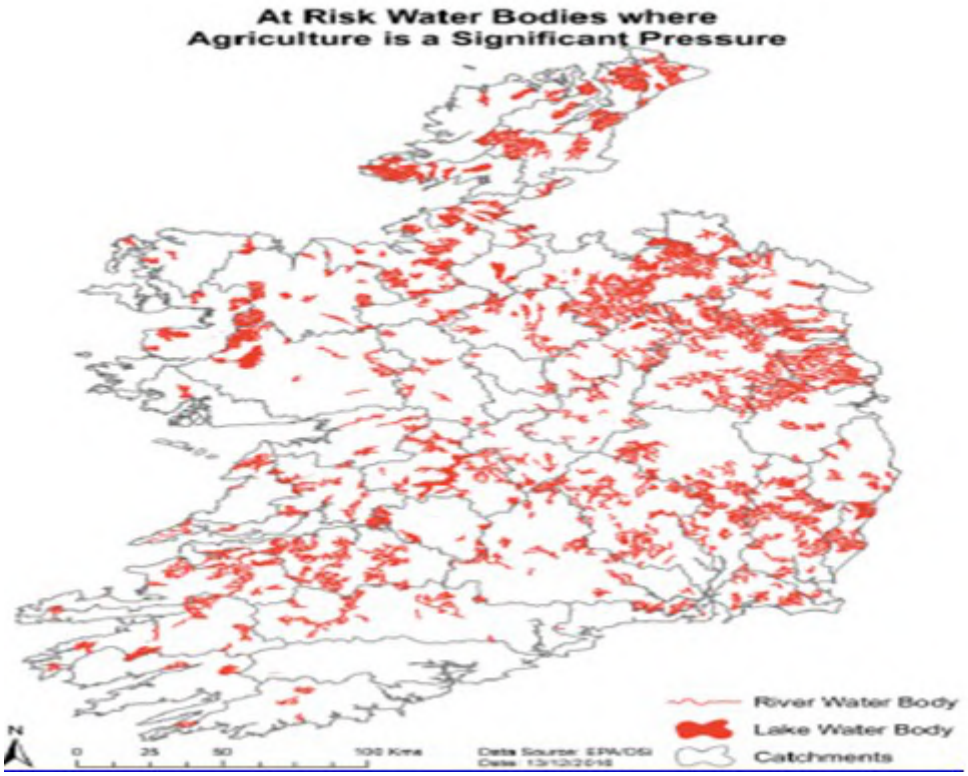


Figure A: Frequency of significant pressures on at risk river and lake water bodies

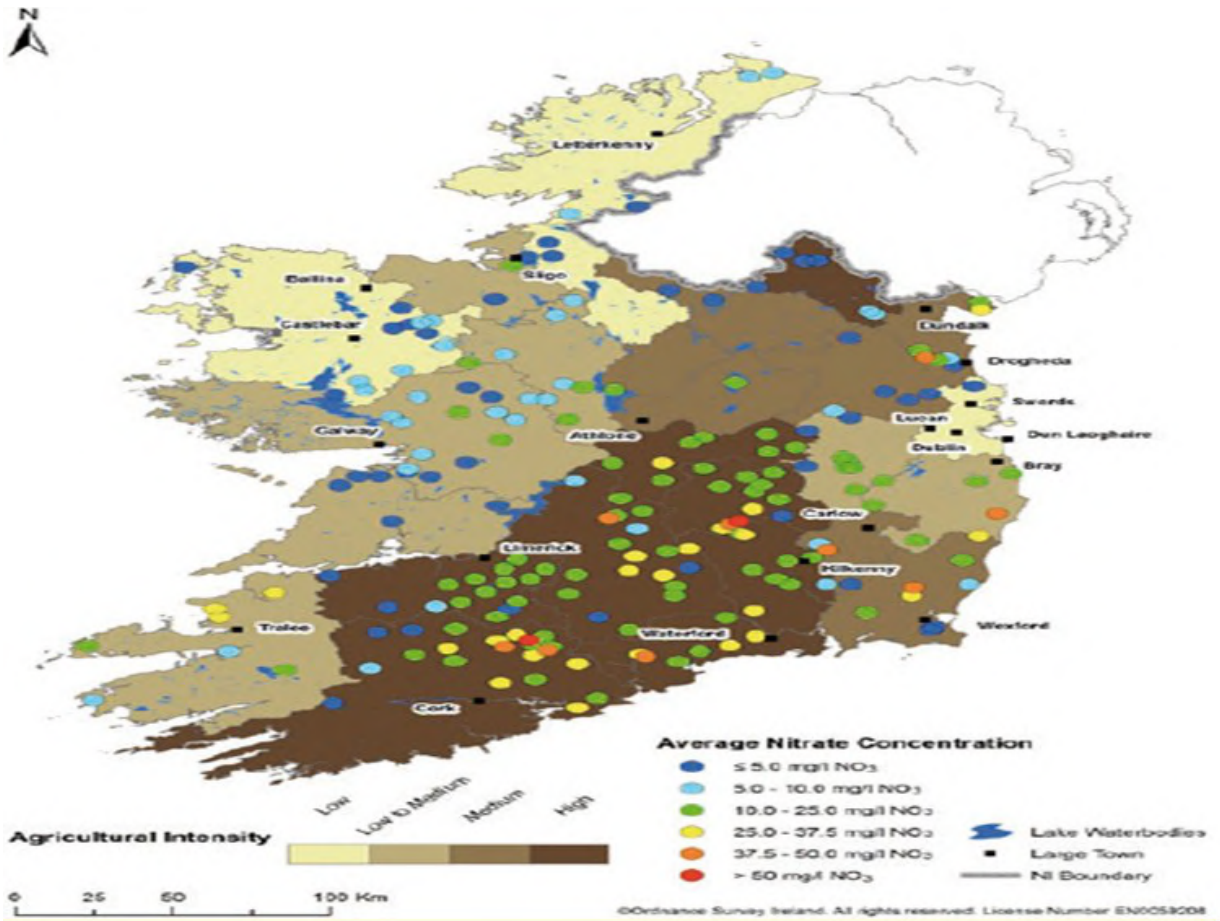
from Ireland's River Basin Management Plan

The below map shows where agriculture is a significant pressure on surface water bodies.



Teagasc, Water Quality and Agriculture, Jenny Deakin, 2018

The below map shows Nitrate Concentrations in Groundwater in 2014 (Source: EPA, 2016b). The south and south-east of the country continue to have the most groundwater sources with elevated nitrate concentrations over 10 mg/l NO_3. These maps show that Irish agriculture is having a serious negative impact on water quality across the entire country. Despite this the Department of Agriculture continues to adopt a policy of agricultural intensification. For this reason the water quality of Ireland's Water Bodies and our aquatic biodiversity will continue to deteriorate.



Nitrate Concentrations in Groundwater in 2014 (Source: EPA, 2016b)

Agricultural Organic Waste Production

The main cause of the pollution of Irish waters is nutrient enrichment. The major source of organic nutrients comes from Ireland's farm animal populations. The below table estimates how much waste is generated by Ireland's animal populations.

Animal	Population	Waste Production kg/day	Total Waste Million Tonnes/yr
Beef Cattle	5,318,000	28.6	55.5
Dairy Cows	1,295,200	55	26.0
Pigs	1,527,800	6.4	3.6
Sheep	3,438,200	2.3	2.9
Chickens (2 month production cycle)	15,000,000	0.23	1.3
Laying hens	4,000,000	0.12	0.2
Turkeys	4,000,000	0.4	0.6
Poultry data from DAFM 2018.		Total:	90 million tonnes

The Irish human population produces about 1kg of waste per person per day or 1.64 Mtonnes/yr. So animal agriculture produces over 50 times the quantity of human waste from the entire population. Animal waste is as polluting to water as human waste. It is high in helminths (worms), protozoa, viruses, bacteria and nitrates and phosphates that go directly into the environment without any treatment. Animal manure/slurry from over wintering of animals is spread directly on the land after an eight week holding period.

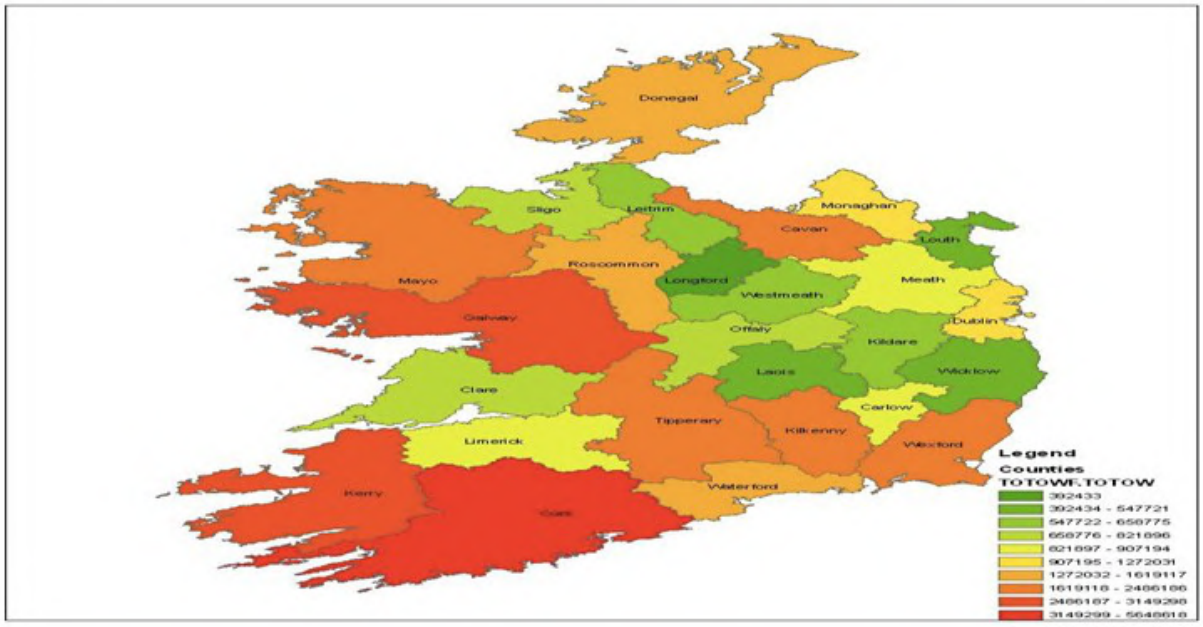
There are approximately 170,000 private wells in Ireland, of which at least 30% are estimated to be contaminated by *E. coli* (EPA, 2015c; Hynds, 2012). Many private wells are at risk of contamination from the landspreading of slurry, animals grazing near the wellhead, and septic tanks. Ireland has the highest rate of VTEC (verotoxigenic *E. coli*) contamination in Europe (EFSA, 2016). VTEC is a particular type of the bacterium *E. coli*. that can be fatal.

A 2008 study entitled 'Composition and Distribution of Organic Waste in Ireland', estimated 37 million tonnes of managed organic waste to have been produced in Ireland in 2006. The report went on to state that these organic wastes contained an equivalent amount of 157,861 and 17,500 metric tonnes of nitrogen and phosphorus, respectively. The below map shows the 2008 distribution of organic waste production.

But based on the above calculations we see that the actual amount of nitrogen and phosphorus is possibly 2.5 times higher at 394,652 and 43,750 metric tonnes of nitrogen and phosphorus, respectively. Uncontrolled spillages of slurry have caused 70 fish kills between 2010 & 2012 (EPA, 2015b). Over 30% of farms inspected each year breached the good agricultural practice regulations.

From sheep farming alone we have 2.3 million tonnes of animal waste entering the environment untreated every year. There is no protection from sheep manure entering local mountain rivers and streams, which are often sensitive to increased nutrient enrichment. The EPA stated that: "In the most recent monitoring period (2013-2015) only 21 sites were classified as the highest quality rivers (0.7% of sites) compared with 575 between 1987 and 1990 and 82 between 2001 and 2003. A 96% reduction over the past 25 years. (Forestry is also a significant pressure on high status water bodies)." Cattle access to riparian areas and watercourses also increases both nutrient and sediment input to streams.

Ireland's farm animals produce over 50 times the waste of the human population.

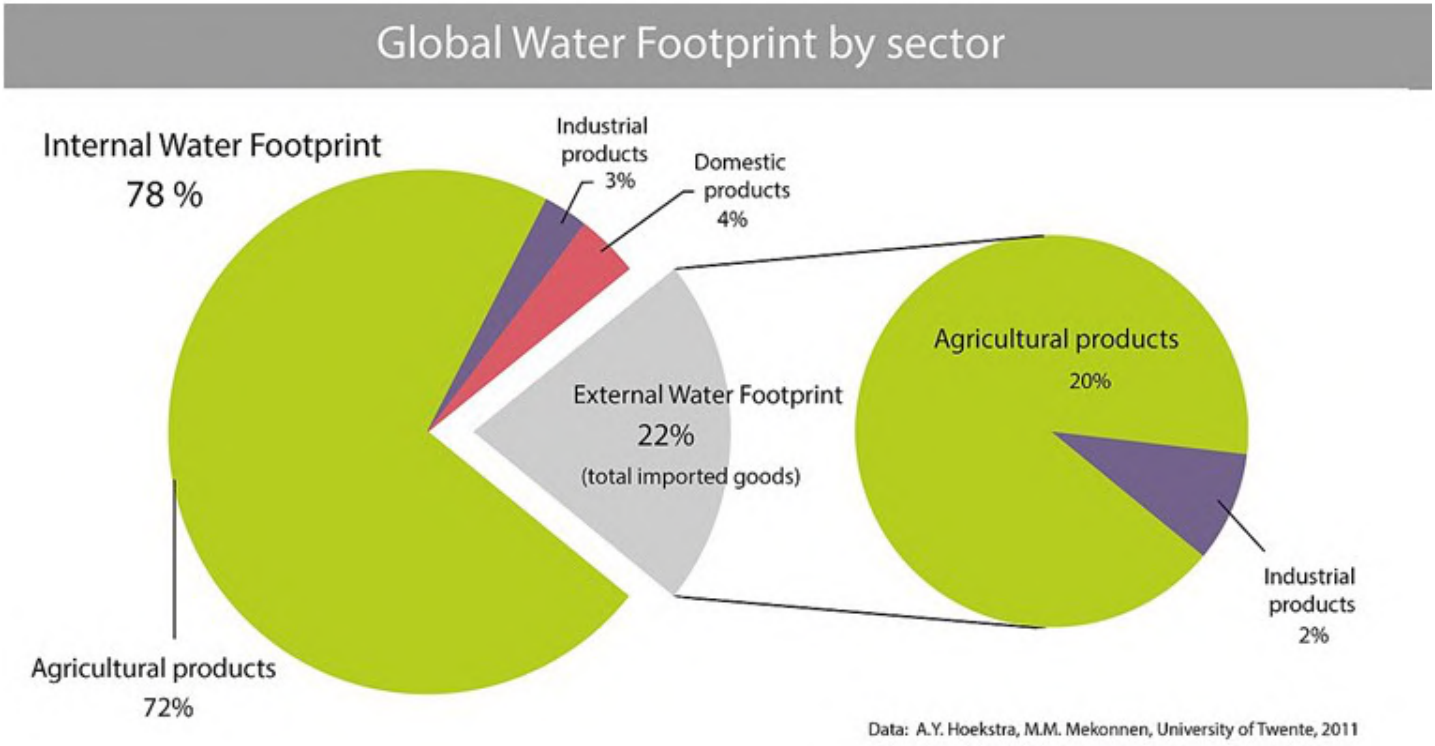


Composition and Distribution of Organic Waste in Ireland, 2011

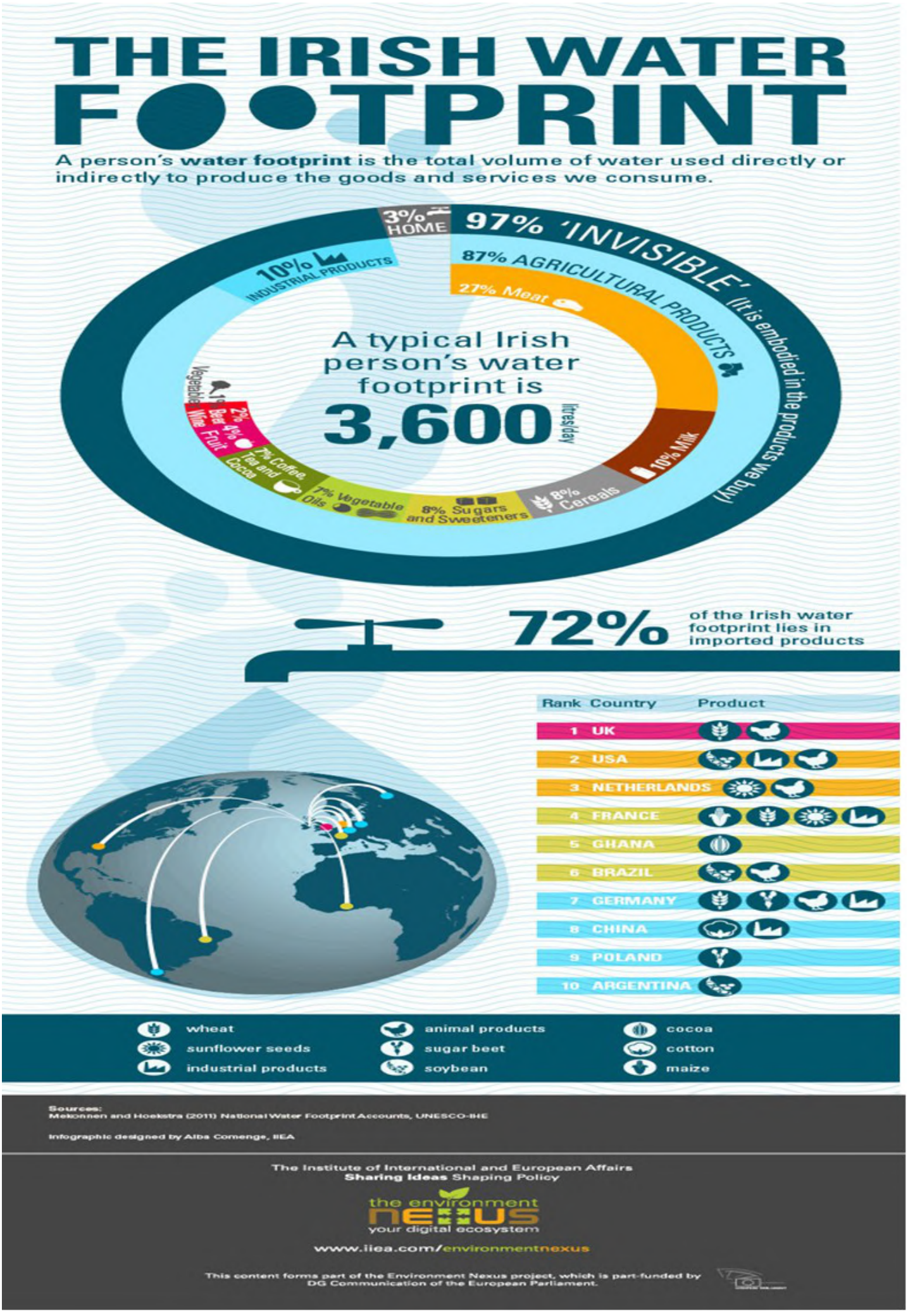
4.2 Water Quantity Impacts

According to the Water Footprint Assessment Manual: "The water footprint can be regarded as a comprehensive indicator of freshwater resources appropriation, next to the traditional and restricted measure of water withdrawal. The water footprint of a product is the volume of freshwater used to produce the product, measured over the full supply chain. It is a multidimensional indicator, showing water consumption volumes by source and polluted volumes by type of pollution; all components of a total water footprint are specified geographically and temporally. The blue water footprint refers to consumption of blue water resources (surface and groundwater) along the supply chain of a product. 'Consumption' refers to loss of water from the available ground-surface water body in a catchment area. Losses occur when water evaporates, returns to another catchment area or the sea or is incorporated into a product. The green water footprint refers to consumption of green water resources (rainwater insofar as it does not become run-off). The grey water footprint refers to pollution and is defined as the volume of freshwater that is required to assimilate the load of pollutants given natural background concentrations and existing ambient water quality standards. This important water resources indicator was developed by Arjen Hoekstra.

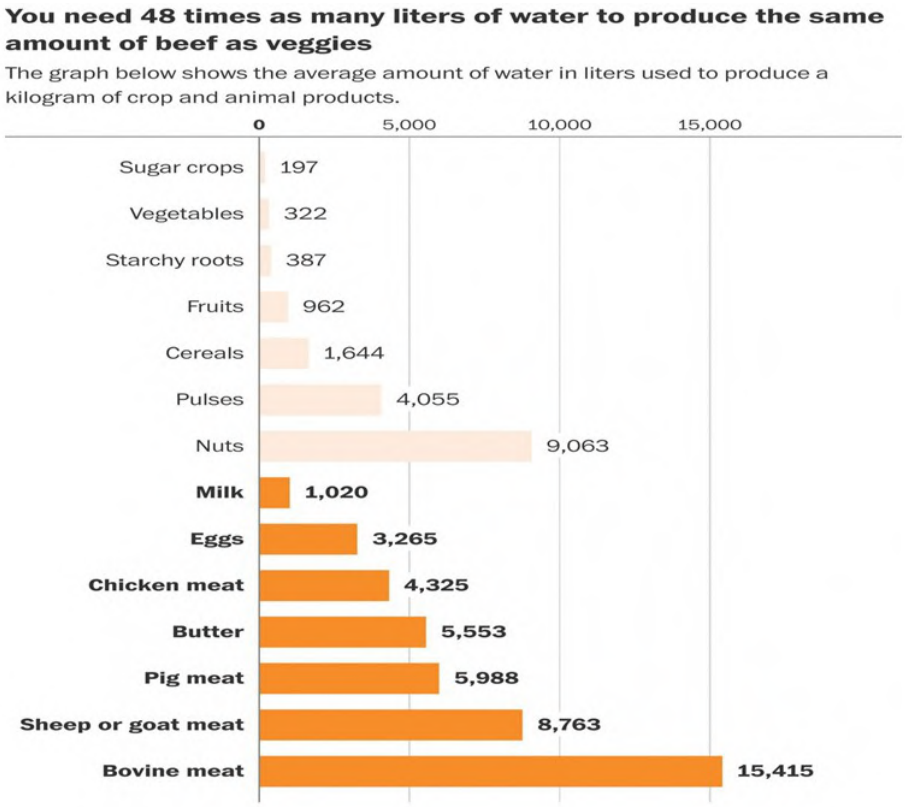
Most of the world's food comes from rain-fed agriculture. Agricultural production accounts for 92 per cent of the global water footprint and almost one third is for animal products. Industrial production takes up 4.4 per cent, while 3.6 per cent is used for domestic water supply. An average of just over one-fifth of a country's water footprint is imported.



The amount of water a person consumes in a day is called a personal daily water footprint. Each Irish consumer's water footprint is 3,600 litres of water a day. Only 3% of this is used at home for drinking or washing. The vast majority (97%) is embodied in the agricultural (87%) and industrial (10%) products we use. The below infographic summarises this information.


THE IRISH WATER FOOTPRINT
A person's water footprint is the total volume of water used directly or indirectly to produce the goods and services we consume.
3% HOME
97% 'INVISIBLE' (It is embodied in the products we buy)
10% INDUSTRIAL PRODUCTS
87% AGRICULTURAL PRODUCTS
27% Meat
A typical Irish person's water footprint is
3,600
litres/day
10% Milk
8% Cereals
8% Sugars and Sweeteners
7% Vegetable Oils
7% Coffee, Tea and Cocoa
4% Fruit
2% Beer
Wine
Vegetables
72% of the Irish water footprint lies in imported products
Rank Country Product
1 UK
2 USA
3 NETHERLANDS
4 FRANCE
5 GHANA
6 BRAZIL
7 GERMANY
8 CHINA
9 POLAND
10 ARGENTINA
wheat
sunflower seeds
industrial products
animal products
sugar beet
soybean
cocoa
cotton
maize
Sources:
Mekonnen and Hoekstra (2011) National Water Footprint Accounts, UNESCO-IHE
Infographic designed by Alba Comenge, IIEA
The Institute of International and European Affairs
Sharing Ideas Shaping Policy
the environment nexus
your digital ecosystem
www.iiea.com/environmentnexus
This content forms part of the Environment Nexus project, which is part-funded by DG Communication of the European Parliament.

As we can see from the above infographic 37% of our water footprint is used to produce meat and dairy. 72% of the Irish water footprint is from imported goods, primarily food products. The below diagram gives the water footprint for a selection of plant and animal foods.



Source: Hoekstra 2012 Rachel Premack /The Washington Post

In order to calculate the amount of water taken out of the Irish Environment we need to calculate the full water footprint for each agricultural product. This includes the water needed to produce the food for the animals which is much larger than the amount of water that is directly consumed. I use the Water Footprint Network Global Data for all products. I have used Oil Seed Rape and Potatoes as samples for different oil seed and vegetable crops.

The RBMP states that Irish Water supplies 652 million m^3/yr for direct human consumption and Irish Water estimates that agriculture uses 153.1 Mm^3/yr. The table below shows that the water footprint of Ireland's Agricultural production in 2017 came to 20,764 Mm^3/yr. This produces enough food for 23 million people.

Current Water Footprint of Irish Agricultural Production

Food Type	Total Production –million kg/yr	Water footprint m3/kg	Water Footprint million m^3/yr
Beef	588	15.42	9,064
Chicken	146	4.33	631
Pork	283	5.99	1,695
Sheep meat	61	8.76	535
Milk	7,500	1.02	7,650
Eggs (No)	700	0.20	137
		Meat Based Foods:	19,712
Spring Wheat	55	1.64	91
Oats	205	1.64	337
Beans and Peas	90	4.06	366
Oilseed Rape	42	2.36	99
Potatoes	412	0.39	160
		Plant Based Foods:	1,052
		Total:	**20,764**

The below table shows the water footprint needed to feed 23 million people with plant based foods would be 10,670 Mm^3/yr, nearly a 50% reduction for the same number of people fed.

Food Type	Total Production –million kg/yr	Water footprint m3/kg	Water Footprint million m^3/yr
Peas and Beans	1,320	4.06	5,359
Grains	1,260	1.64	2,066
Oilseed Rape	410	2.36	968
Potatoes	5,837	0.39	2,276
		Total:	10,670

The agricultural footprint of 20,764 Mm^3/yr includes water abstracted from surface and groundwater sources, the rain water needed to grow fodder crops and the water needed to disperse the agricultural pollutant streams. It is a much more realistic picture of agricultural water use than the Irish Water estimate of 153.1 Mm^3/yr.

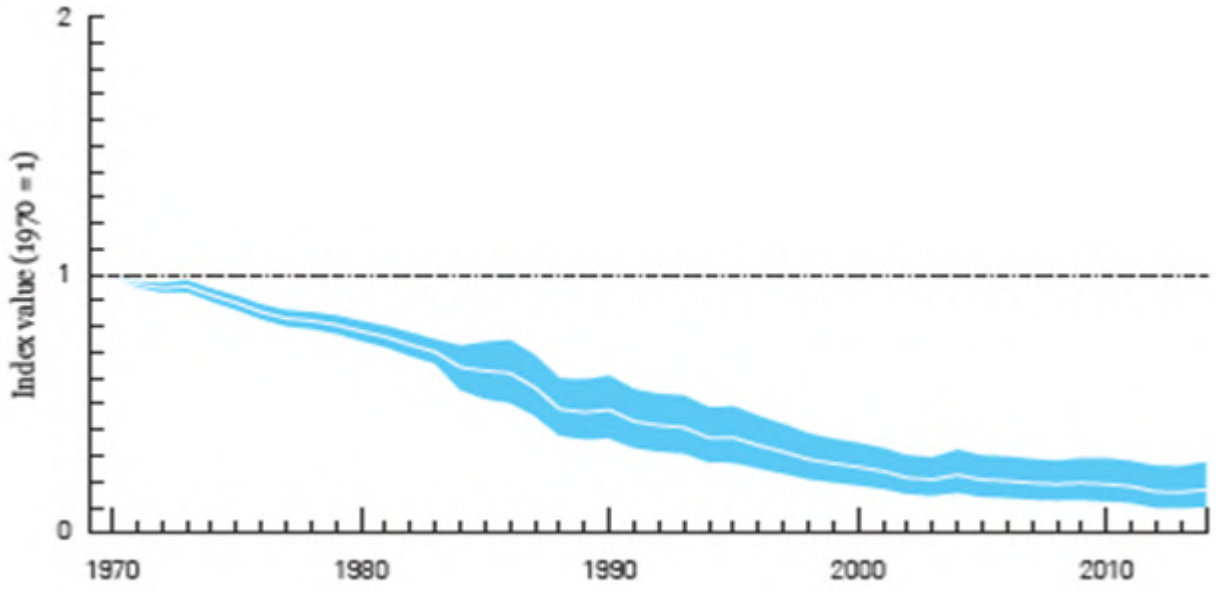
In Part 3 of the Food Security Chapter we calculated that plant based agriculture on 4 Mha could feed 155 million people. The water footprint for these crops is given below.

Food Type	Total Production –million kg/yr	Water footprint m3/kg	Water Footprint million m^3/yr
Peas and Beans	9,900	4.06	40,194
Grains	10,080	1.64	16,531
Oilseed Rape	2,050	2.36	4,838
Potatoes	35,920	0.39	14,009
		Total:	75,572

4.3 How Agriculture Affects Aquatic Biodiversity

Globally freshwater ecosystems provide habitat for at least 126,000, or around 1 in 10, known species of fishes, molluscs, reptiles, insects, plants and mammals despite covering less than 1% of the Earth's surface. These ecosystems are also the most threatened – they are strongly affected by habitat modification, fragmentation and destruction; invasive species; overfishing; pollution; forestry practices; disease; and climate change. In many cases, these combined threats have led to catastrophic declines in freshwater biodiversity.

The 3,358 populations – representing 880 species of mammals, birds, amphibians, reptiles and fishes – in the Freshwater LPI show an 83% decline, equivalent to 4% per year since 1970. The largest declines are seen in populations in the Neotropics (-94%), the Indo-Pacific (-82%) and the Afrotropics (-75%), especially in reptiles and amphibians, and in fishes.



Living Planet Freshwater Index, WWF 2018

In Ireland protected water dependent habitats and species are present in 849 water bodies. Out of these water bodies 40% of rivers, 31% of lakes, 63% of transitional waters, and 42% of coastal zones did not meet good or high status. 90% of designated Natura 2000 water dependent habitats have an unfavourable conservation status and 50% of Natura 2000 water dependent species have an unfavourable status. According to the 'National Parks and Wildlife Service (NPWS) Red List No. 5: Amphibians, Reptiles & Freshwater Fish': "the spread of invasive species like Roach has been facilitated by increasing eutrophication pressures in many Irish lakes." They note that there is overall a change in water habitats "towards less stable, more nutrient enriched status where a simplification occurs that favours invasive more generalist species with high fecundity over our cold water, post glacial native fish species."

In Ireland the European Eel is critically endangered and the Natterjack Toad is endangered. Among our freshwater fish species Pollan, Char, Twaite, Killarney Shad and Atlantic Salmon are vulnerable. All of these species are impacted by agricultural practices as well as other pressures. For example, Pollan and Char, that require cool deep waters unimpacted by nutrient enrichment, have gone extinct from a number of lakes over the past 40 years. 57% of designated freshwater pearl mussel populations do not meet the high water quality status needed for this indicator species. In addition, over 15% of Irish water beetle species, butterfly species and dragonflies and damselflies are threatened.

Agricultural practices have particular impacts on aquatic biodiversity due to the physical changes they bring about in the environment. The RBMP identified that changes to hydromorphology affected 19% of the 1,134 at risk water bodies due to drainage, overgrazing, etc. Physical modifications of water bodies can reduce the diversity of plant and animal communities either directly by affecting habitats or indirectly by changing natural processes. Land drainage and development, overgrazing, and cattle access can cause impacts such as bank erosion and siltation or increased risk of flooding due to faster runoff. Overgrazing can increase erosion rates, significantly disturbing siltation and hydrology regimes, and can cause physical damage and loss of habitat in rivers which can adversely impact fish community composition and size. According to the NPWS: "Overgrazing in uplands has led to substantial siltation in gravel beds and rivers in the west. These impacts can occur in remote and poorly-buffered habitats on hard rock where there are no other human impacts." Furthermore they note that: "Current riparian tree cover is very patchy. The retention of tree lines along rivers and streams may serve to provide shading and cooler thermal regimes for salmon and brown trout." "Habitat loss, in particular wetland drainage and infilling is a major threat to Irish Amphibians. Terrestrial habitat is also important for these species and excessive clearance of vegetation around breeding sites, removal of hedgerows and scrub can have a detrimental effect on local breeding populations." Extensive deforestation and species extinction has already taken place in Ireland and once thriving and biodiverse ecosystems have been replaced with an intensively managed grass monoculture for meat and dairy production. These land use and biodiversity changes continue to have a major negative impact on the health of our rivers and lakes.

4.4 Ecological Restoration for Aquatic Ecosystems

This section provides some brief extracts from two reports outlining how ecological restoration can reduce flooding and soil erosion while at the same time restoring healthy aquatic ecosystems. The reports are titled, 'The Water-retention potential of Europe's forests, A European overview to support natural water-retention measures, 2015' and 'Natural Flood Management, Adopting ecosystem approaches to managing flood risk in Ireland, 2017'.

Agricultural Land Management

Heavily engineered flood alleviation and flood protection works has been the focus of flood management to date. However the root causes of flooding – land management and loss of functional floodplains – are rarely addressed. Agricultural intensification, in particular in floodplains, can reduce the ability of land to absorb and slow floodwaters, thus exacerbating flooding downstream. Both soil compaction and the removal of semi-natural habitats such as wetlands, woodland, scrub and hedgerows reduces the ability of land to absorb or store water and speeds up overland flow into river channels. On intensively managed land, **soil compaction** through sustained use of heavy machinery can reduce the absorptive capacity of soil and thus increase rates and speed of overland flow. Bare ground in winter can accelerate runoff simply by the lack of vegetation which creates surface roughness. Leaving soils un-vegetated in winter results in soil erosion and can negatively impact the productivity of soils.

Throughout Ireland **field drains** have been put in place to dry out the land and improve agricultural productivity. The cumulative impacts of field drainage over a sub-catchment can act to accelerate runoff into streams, overall speeding up the time it takes for large volumes of water to enter river channels and thus increasing flood risk. In catchments where this is found to contribute to flooding, breaking field drains to restore wet grassland and even to re-create wetlands in these areas to attenuate flood peaks should be considered. This will result in lower agricultural productivity in those locations. In other fields where losing productivity is not desirable, integrated drainage to link runoff to features such as wetlands or to engineered flood storage areas could attenuate flooding.

Flood Reduction Benefits of Reforestation

In catchments where the forest cover is 30%, water retention is 25% higher than in catchments where the forest cover is only 10%. If the forest cover is 70%, water retention is 50% higher than in catchments where the forest cover is only 10%.

The extent to which woodlands attenuate flood risk is dependent on its species composition and management. Semi-natural woodlands with limited management are thought to offer greater scope for flood reduction than more managed plantation forests. A study was carried out in Wales: "To develop an evidence base to help predict the impacts of land management change on flood generation, four experimental sites were established on improved grassland used for sheep grazing at the Pontbren catchment in upland Wales, UK. At each site, three plots were established where surface runoff was measured, supplemented by measurements of soil infiltration rates and soil and vegetation physical properties. Following baseline monitoring, treatments were applied to two of the plots: exclusion of sheep (ungrazed) and exclusion of sheep and planting with native broadleaf tree species (tree planted), with the third plot acting as a control (grazed pasture). On average, post-treatment runoff volumes were reduced by 48% and 78% in ungrazed and tree-planted plots relative to the control, although all results varied greatly over the sites. Five years following treatment application, near-surface soil bulk density was reduced and median **soil infiltration rates were 67 times**

greater in plots planted with trees compared to grazed pasture. The results illustrate the potential use of upland land management for ameliorating local-scale flood generation." Woodland creation also has greatly differing impacts on flood attenuation depending on the location in the catchment. **Floodplain woodlands** are thought to offer the greatest potential for downstream flood mitigation.

Additional benefits of Reforestation

Woodlands can help **mitigate against climate change** when managed as a permanent landscape feature. Riparian woodlands generally help to improve water quality by **absorbing diffuse nutrients** which arise primarily from agriculture and plantation forestry, as well as **trapping sediment** from running off land into waterways. Sediment becomes a problem when too much of it enters rivers, and as the amount of sediment arising from erosion increases with heavy rainfall, trapping sediment is one of the challenges to be addressed in climate change adaptation. With increased frequency and severity of precipitation events likely to arise from climate change, this is an important climate change adaptation measure. Conversely, artificial fertilisers applied for commercial forests can result in nutrient pollution to waterways, and soil disturbance from forest management can cause sedimentation.

Implementing woodland creation for flood attenuation

In England, the Forestry Commission has worked with the Environment Agency to implement a 'Woodlands for Water' scheme. Landowners are incentivised with Rural Development Program (RDP) payments to target planting to reduce flood risk and/or diffuse pollution. This payment for landowners is additional to the existing grant offered for afforestation under the national afforestation plans.

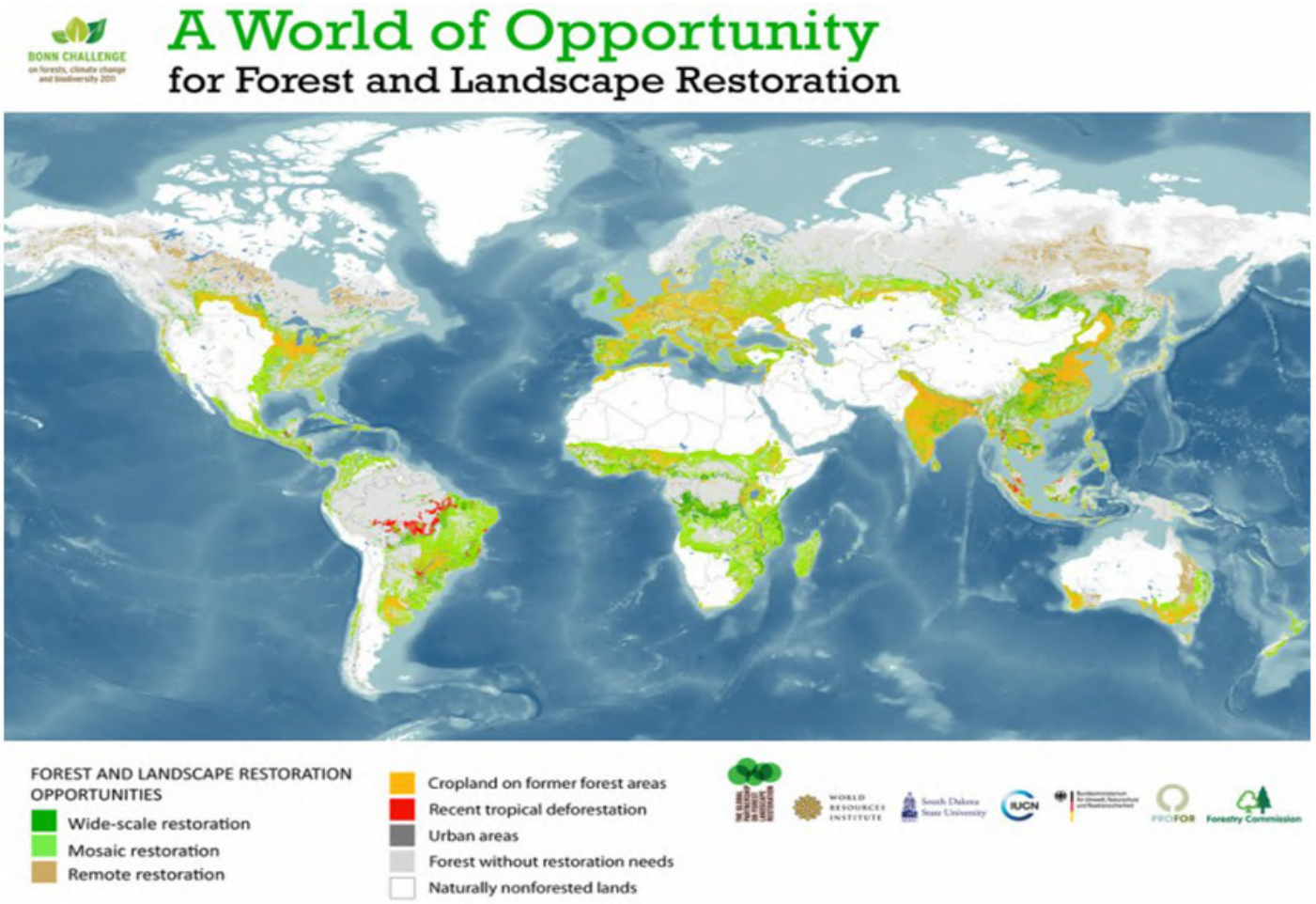
Planting hedges along the contour of a field can also help to intercept runoff, in addition to the roots of hedgerow trees aiding infiltration of water. As with other natural flood management measures, hedgerow planting will only achieve flood alleviation service if targeted at the right locations, in this case planting along contour lines, on specific slopes where runoff should be targeted, and in floodplains.

Similarly, **agroforestry**, by incorporating trees into productive agricultural land has been shown to greatly increase soil water infiltration capacity, thus slowing run-off and contributing to flood attenuation. Evidence shows that there are significant merits for reducing local flood risk by having fenced-off tree areas in silvo-agricultural settings.

Recommendations

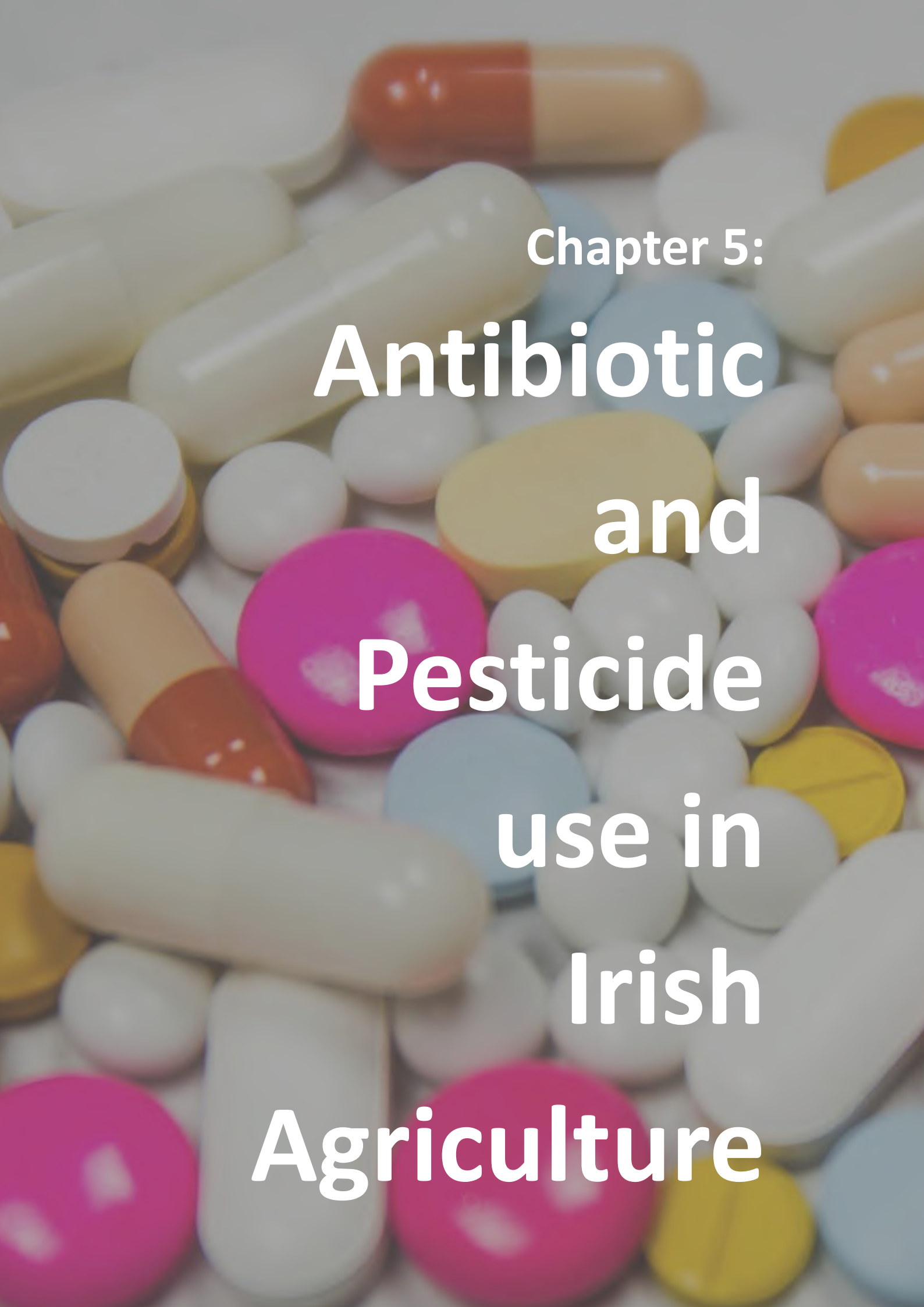
There is a strong case to be made for utilising CAP funds for flood management, for specific targeting of agricultural subsidies toward implementing flood management measures on agricultural land. In the UK, agriculture has been estimated to account for 14% of flooding, which in turn results in annual flood management costs of £464 million and damage costs of £1.09 billion in England and Wales. In Ireland, as part of the transition to a VAS, the Forest Service and local farmers would consider which lands are best to transition to forest, which to wetlands in areas where hydrological data indicates that flood alleviation benefits would be delivered.

Conservation project involving appropriate restoration works within an existing native woodland adjoining a watercourse, Forest Service, Dept. of Agriculture



"Without meat and dairy consumption, global farm land use **could be reduced by more than 75%** – an area equivalent to the US, China, EU and Australia combined – **and still feed the world**." – Reducing food's environmental impacts through producers and consumers: J. Poore, T. Nemecek, June, 2018.

Globally and in Ireland, a transition to a VAS together with payments to land owners for ecological restoration has huge potential to enable biodiversity to recover, flooding to be reduced, and the sequestration of Carbon Dioxide helping to reduce Ireland's GHG emissions.



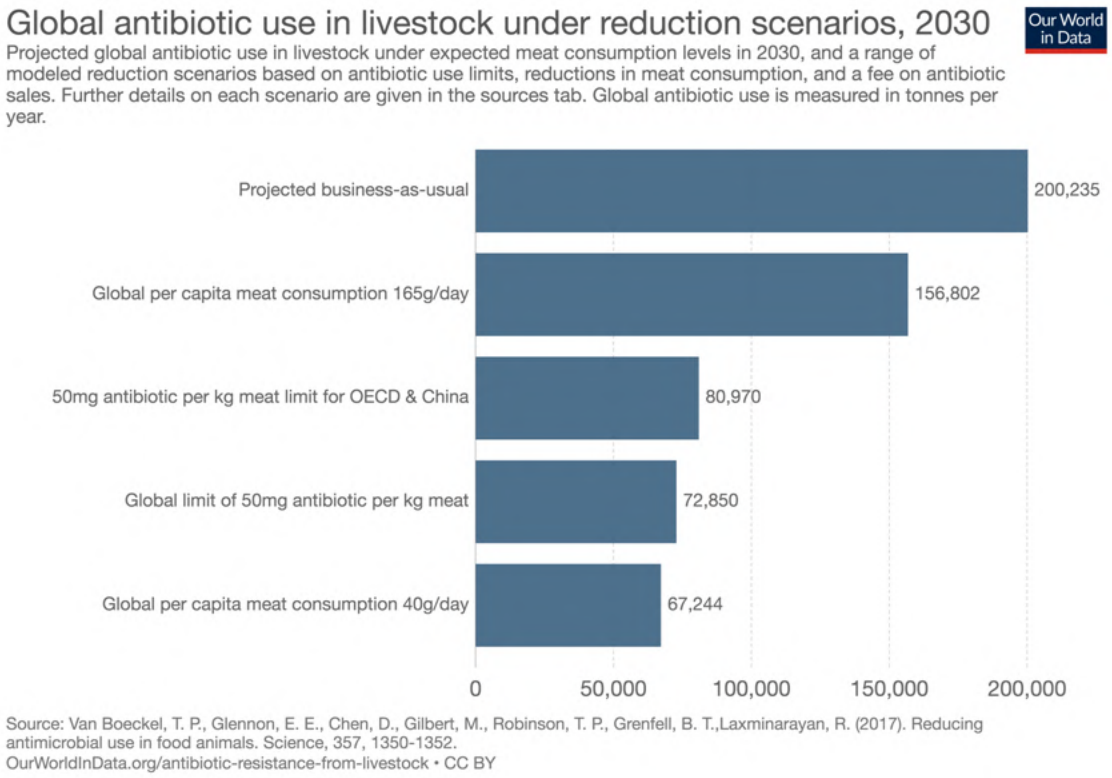
Chapter 5:

Antibiotic and Pesticide use in Irish Agriculture

Chapter 5: Antibiotic and Pesticide Use in Irish Agriculture

This section describes the scale and impacts of the use of antibiotics and pesticides on human and ecological health.

Industrial livestock is strongly associated with antimicrobial resistance (resistance to antibiotics), which the World Health Organization recently declared a "global health emergency". A 2019 UN Report states that "Drug-resistant diseases already cause at least 700,000 deaths globally a year, including 230,000 deaths from multidrug-resistant tuberculosis, a figure that could increase to 10 million deaths globally per year by 2050 under the most alarming scenario if no action is taken. Around 2.4 million people could die in high-income countries between 2015 and 2050 without a sustained effort to contain antimicrobial resistance." This is more than the number of people that currently die of cancer.



Globally human medicine accounted for 40,000 tonnes of antibiotic use in 2013 while Animal Agriculture and Aquaculture accounted for 131,000 tonnes or **76%** of antibiotic use worldwide. 90% of antibiotics enter the environment unmetabolised. By 2030 this will continue to increase as shown below depending on the level of meat consumption. The only way to end the reckless misuse of antibiotics, that is already costing human lives, is a VAS.

The joint report by the European Centre for Disease Prevention and Control, the European Food Safety Authority and the European Medicines Agency, published in 2017, showed that in 2014 the use of antibiotics for animals in the EU-28 was more than double the use for human medicine. In the EU, 33,000 people die annually due to infections caused by resistant bacteria, which translates into €1.5 billion in extra health care costs and productivity losses every year. According to the data from the **EU Medicines Agency**, medicines classified as "**critically important in human medicine**" by the WHO appear to be in frequent use on farm animals across the EU.

5.1 Antibiotic Use in Irish Agriculture

In the Report on consumption of veterinary antibiotics in Ireland during 2015 by the Health Products Regulatory Authority data was collected on a total of 55 individual antibiotic substances contained in over 800 product presentations, which have been authorised for use in Ireland. The data is based on self-declarations by applicant companies and has not been subject to independent verification or audit. Animal demographics change over time. In order to account for this the Population Correction Unit (PCU) has been established as a denominator for the sales data. PCU for each animal category is calculated by multiplying numbers of livestock animals and slaughtered animals by the theoretical weight at the most likely time for treatment. Exported and imported animals are also taken into account. 1 PCU = 1 kg of animal biomass. Use of veterinary antimicrobials was 53 mg/PCU in 2016, which amounted to 103.4 tonnes.

According to the Irish Government's 2019 'One Health Report on Antimicrobial Use and Resistance', human use of antimicrobials was 155.6 mg/kg in 2014 which worked out at approx. 50.3 tonnes (with a population of 4.638 million and an average weight of 70 kg). So the total antibiotic use in Ireland = 50.3 tonnes + 103.4 tonnes = 153.7 tonnes. **Two thirds of antibiotics used in Ireland are given to farm animals.**

The majority of these antibiotics are used, not to treat infections

but for disease suppression and growth enhancement and they are regularly administered in animal feed and water, and to call them veterinary antibiotics is misleading. According to a US Food and Drug Administration (FDA) Report, 93% of medically-important antibiotics were administered via feed or water in agriculture in the US. Scientific studies also suggest that **75-90% of tested antibiotics are excreted from animals un-metabolised** and enter the environment and water sources. Therefore, animal waste not only contains resistant bacteria, but also antibiotics that could then foster the emergence of microbial resistance in bacteria beyond those in an animal's gut – including bacteria that may pose a greater risk to humans. Waste disposal from the Pharmaceutical Sector who are involved in the manufacture of antibiotics can release antimicrobials in the aquatic environment in high concentrations and are an important source of antibiotic residues entering the environment.

"Preliminary results from EPA-funded research undertaken by the National University of Ireland Galway in collaboration with University College Dublin has found that antimicrobial residues are present in hospital effluent and in municipal sewage downstream from hospital effluent discharge points, at levels that could promote antimicrobial resistance formation." A great deal more research is needed including an extensive monitoring program to identify the concentrations of antibiotics in our water bodies and the effects they are having on the ecosystem, in particular soil microbiota and water bodies used as water supply sources. But the only solution to eliminate the use of these vitally important antimicrobials in our food system is a Vegan Agricultural System.

Sales of veterinary antibiotics, 2012-2016

	2012	2013	2014	2015	2016
Tonnes sold	97.4	99.1	89.4	96.9	103.4
PCU (1,000 tonnes)	1725	1762	1866	1892	1963
mg/PCU	56	56	48	51	53

Health Products Regulatory Authority Presentation, 2018

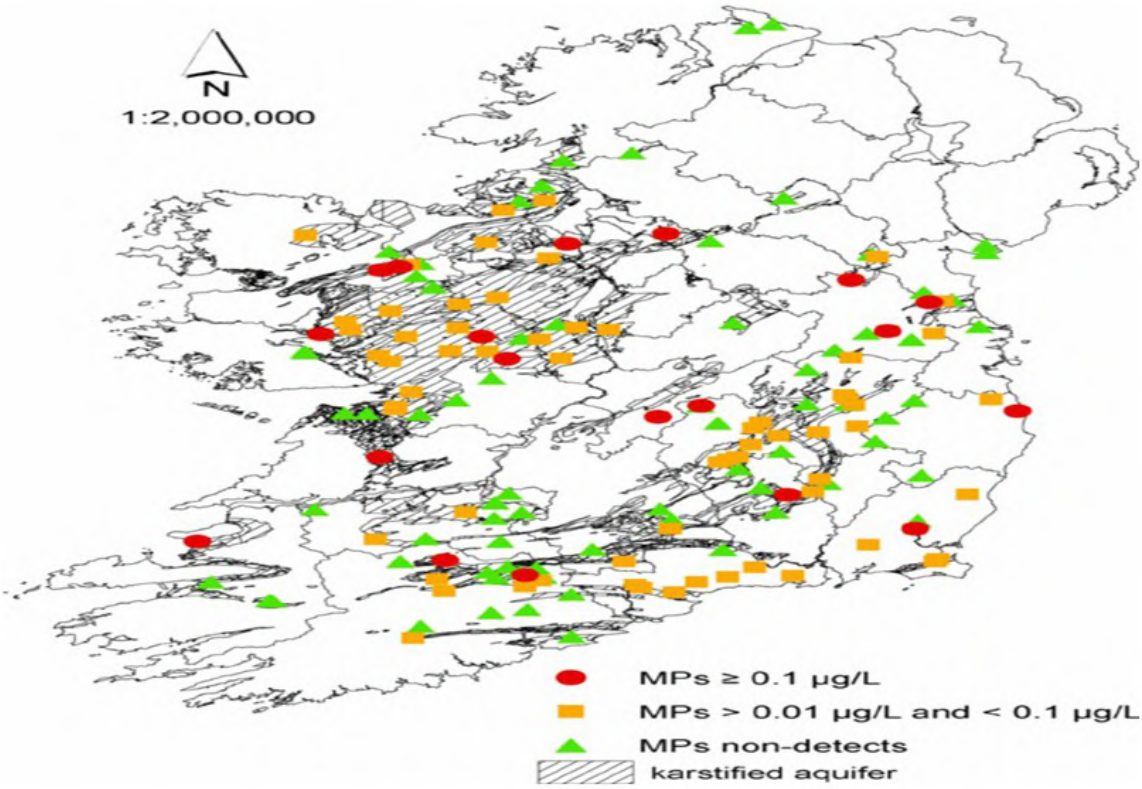
5.2 Pesticide Use in Irish Agriculture

In January 2017 the UN Special Rapporteur on the Right to Food produced a report on pesticides for the UN General Assembly, which stated that: "Pesticides cause an array of harms. Runoff from treated crops frequently pollute the surrounding ecosystem and beyond, with unpredictable ecological consequences. Furthermore, reductions in pest populations upset the complex balance between predator and prey species in the food chain, thereby destabilizing the ecosystem. Pesticides can also decrease biodiversity of soils, which can lead to large declines in crop yields, posing problems for food security." He goes on to state that: "Without or with minimal use of toxic chemicals, it is possible to produce healthier, nutrient-rich food, with higher yields in the longer term, without polluting and exhausting environmental resources. The solution requires a holistic approach to the right to adequate food that includes phasing out dangerous pesticides and enforcing an effective regulatory framework grounded on a human rights approach, coupled with a transition towards sustainable agricultural practices that take into account the challenges of resource scarcity and climate change." The Danish Government has recently produced a plan to double their country's agricultural land under organic production by 2020. But what is needed is to eliminate the use of pesticides and herbicides entirely and transition to an organic VAS.

Grass and Crop production in Ireland relies extensively on the use of Plant Protection Products (PPPs). This reliance on chemical treatment results in over **2 million kg** (active ingredients) of synthetic pesticides being applied to crops (both forage and arable) annually (2008). According to the Department of Agriculture 3 million Kg of active ingredients were sold in Ireland in 2015. There are 877 different types of pesticides used in ROI. The six most widely used pesticides are MCPA, Glyphosate, Chlorothalonil, Mecoprop-P, Chlormequat and Mancozeb. County Louth is the highest consumer of pesticides in ROI with an average active substance application rate of 146.7 kg/km^2. In contrast, County Mayo is the lowest contributor with an average application rate of just 3.7 kg/km^2 due to different farming practices. The main areas of pesticide use are in Leinster (excluding Wicklow) with the least use along the west coast. In 2015 there were 3,121 tonnes of plant protection products put on the market (this includes sales to the public as well as use by local authorities).

In 2013 a report entitled the Current Status of Pesticides Application and their Residue in the Water Environment in Ireland (Zhao, Y.Q.; Singleton, P.; Meredith, S.; et al.) was published. This study discusses the application of pesticides and the potential impact on the Irish water environment by outlining the pathways by which pesticides enter the aquatic environment and examining the status of pesticide residue in the Irish water environment. According to the EPA State of the Irish Environment 2016 a number of pesticides, including Mecoprop, MCPA and 2,4 -D, have also been detected at low levels in a very high percentage, "26–56% of rivers during routine monitoring." So we know that this is a problem. How these harmful chemicals interact and their cumulative effect on the environment is not known. The below map shows the incidence of pesticide contamination of groundwater in a two year study published in 2014. Irish water has stated that one drop of MCPA is sufficient to pollute a 30 km stretch of water. Irish water purification plants do not have the capacity to remove pesticides.

The below diagram shows the Spatial-distribution of Pesticide Monitoring Points with detections exceeding EU limits, and Monitoring Points which never had a pesticide detection throughout the 2-year monitoring campaign.



In its 2016 State of the Irish Environment the EPA stated that it organised: "A successful 2013-2014 joint initiative to facilitate the collection, recovery and disposal of hundreds of tonnes of hazardous waste from farms." But this programme, while helpful, collected only "32 tonnes of pesticides including insecticides, fungicides and herbicides including many that are extremely toxic to both human health and the environment." This is about 1% of the three thousand tonnes that is released into the Irish environment each year.

5.3 Other Environmental Impacts of Irish Agriculture

Irish agriculture produces other significant waste streams and environmental impacts.

1. Zoonotic Diseases
Intensive livestock factory farms, with their high densities of confined animals, have been shown to increase the transmission of diseases from animals to humans.

2. Other Animal Agriculture Waste Streams
According to the EPA State of Irish Environment Report 2016 approx. 500,000 tonnes of raw Animal By-Products are produced by slaughterhouses and meat processing plants each year. This is mainly rendered to produce pet-food (70,000 tonnes), meat-and-bone-meal (61,000 tonnes), tallow (33,000 tonnes), and biofuel (27,000 tonnes) leaving over 300,000 tonnes of hazardous waste for disposal.

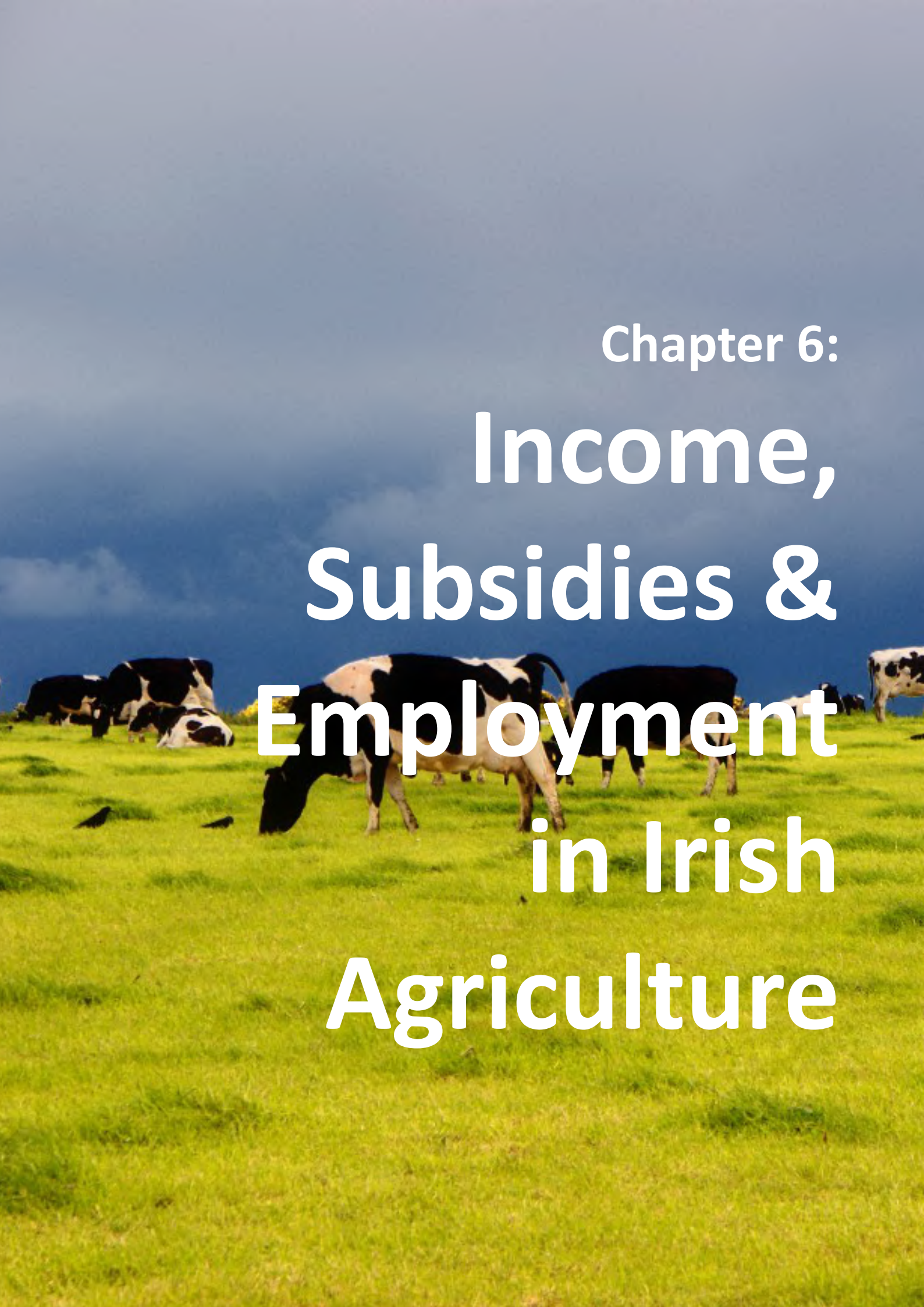
Of the 7.5 Mt of milk that is produced, over 0.5 Mt are consumed as milk and the remainder is converted to cheese, butter and skim milk powder with over five million m^3 of waste waters. Millions of litres of water are also used in milking parlours and these significant volumes of washings are contaminated with e-coli and other pathogens.

3. Genetically Modified foods
Genetically Modified foods are now being used as animal feed. It is not known what effect these will have on our health or our environment. When you eat meat and dairy in Ireland you are eating animals that have been fed Genetically Modified Maize and Soy.

4. Artificial fertilizers
Ireland had the seventh highest usage of fertiliser in the EU in 2015, at 94.7 tonnes per thousand hectares of agricultural land. A total of 368,000 tonnes of fertilisers (331,000 tonnes of Nitrogen and 37,000 tonnes of phosphorous) were sold in 2015.

5. Ammonia (NH_3)
"Industrial livestock production contributes heavily to air pollution, with over 80% of EU agricultural NH_3 emissions to air linked to livestock. Factory farms contribute to air pollution, which authorities consider the single largest environmental health risk in Europe, causing over 400,000 premature deaths per year. Livestock production accounts for the largest share of air pollutants created by agriculture, specifically NH_3, particulate matter and non-methane volatile organic compounds".

98% of Ireland's NH_3 emissions arise from activities in the agricultural sector. The emission ceiling for NH_3 under the previous Gothenburg protocol was 116 kt. Under the revised National Emissions Ceiling Directive, Ireland's targets for 2020 and 2030 have been amended to a 1% reduction for 2020 and a 5% reduction for 2030 (based on a 2005 baseline). According to the EPA: "Ireland's planned implementation of Food Wise 2025 will lead to a risk of higher NH_3 emissions. NH_3 emissions can lead to the formation of aerosol particulate matter and eutrophication."



Chapter 6:

Income, Subsidies & Employment in Irish Agriculture

Chapter 6: Income, Subsidies & Employment in Irish Agriculture

This section will address the following questions:

1. How much do current meat based food production industries contribute to the economy, including exports and imports?
2. What is the current state of Irish Farmer income and the level of subsidies?
3. How many people are currently employed in animal agriculture industries and how are these jobs distributed between farming and food processing?

6.1 The Economics of Ireland's Agri-Food Sector

In 2016 Ireland's Trade generated €196 billion with exports totalling €121 billion and imports €75 billion. The agri-food Sector including beverages, oils, and fertilisers contributes approx. €13.7 billion (11%) of exports (an increase of 11% on 2016), and costs approx. €9 billion (12%) in imports. By comparison, our total energy imports amount to €4.7 Billion.

The below table shows the Gross Value Added (GVA) from the Primary Agriculture, Fisheries and Forestry Sectors as well as GVA from the Food and Wood Processing Sectors. It's worth noting that there is more than double the value added in the processing phase (€9,612 million) compared to agriculture, with only about half the number of people employed. This processing sector would expand under a VAS.

	€m
Gross Domestic Product (GVA) at Factor Cost	€254,715
GVA in Primary Agriculture, Fisheries and Forestry at Factor Cost	€4,093
GVA in Food & Beverages Sector	€9,612
GVA in Wood Processing (estimated)	€198
Total	€13,903
GVA in Primary Sector as a % of GVA	1.6%
GVA in overall Agri-Food Sector as % of GVA	5.5%

Source: Central Statistics Office, National Income and Expenditure, 2016

The primary agricultural, fisheries and forestry sectors contribute 1.6% of GVA while the overall agri-food sector contributes 5.5%.

The following table shows the profits, costs and income in the agriculture sector in 2016 and 2017. **In 2016 the agricultural sector delivered a profit of €2.588 billion of which €1.592 billion was from subsidies.** In 2017 the agricultural sector delivered a profit of €3.498 billion of which €1.650 billion was subsidies. The profit without subsidies would be €1.848 billion.

In the below table we see that in 2017 €5,203 Million was spent by farmers on 'Intermediate Consumption'. This would include everything from fuel and electricity to contractors to supplies like grass seed, fertilisers and antibiotics. With the transition to plant based agriculture the products being purchased would change, but they would still be significant as the area of land for crops and horticulture is more labour and technology intensive than animal agricultural systems as shown in the Netherlands Case Study in the chapter on the Future of Food.

Financial Output, Costs and Income in Irish Agriculture, 2016 – 2017

	2016 Value €m	2017 Value €m	% Change 2016 - 2017
Goods Output at Producer Prices	€7,057.9	€8,016.2	+13.6%
Contract Work	€361.5	€361.5	+0.0%
Subsidies less Taxes on Products	€0.2	€0.9	
Agricultural Output at Basic Prices	€7,419.6	€8,378.5	+12.9%
Intermediate Consumption	€5,103.4	€5,203.0	+2.0%
Gross Value Added at Basic Prices	€2,316.1	€3,175.5	+37.1%
Fixed Capital Consumption	€812.7	€812.7	+0.0%
Net Value Added at Basic Prices	€1,503.4	€2,362.8	+57.2%
Other Subsidies Less Taxes on Production	€1,592.1	€1,649.6	+3.6%
Factor Income	€3,095.5	€4,012.5	+29.6%
Compensation of Employees	€507.7	€514.8	+1.4%
Operating Surplus	€2,587.9	€3,497.6	+35.2%

Source: Central Statistics Office, Output, Input and Income in Agriculture Final Estimates, 2017

6.2 Economic Overview of Ireland's Farms – Teagasc National Farm Survey

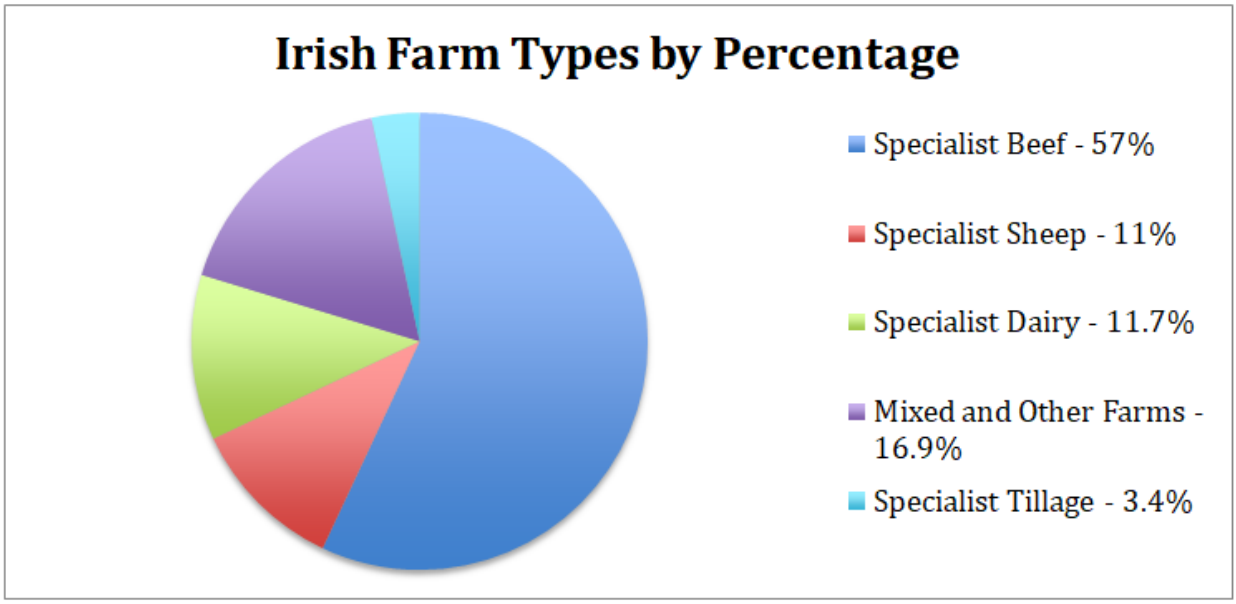
The CSO Structure of Farming in Ireland 2016 Survey (FSS) states, "There was almost 4.9 Mha of Agricultural Area Used (AAU) in 2016 in Ireland, including 0.43 Mha of commonage." Below is a breakdown of Irish Agricultural Land Use.

CSO Infographic

The below table and graph is a breakdown of the 137,500 farms in Ireland from the FSS.

Farm Type	% of Farms	Total No of Farms
Specialist Beef	57%	78,375
Specialist Sheep	11%	15,125
Specialist Dairy	11.7%	16,088
Mixed and Other Farms	16.9%	23,238
• Mixed Grazing	• 8.4%	• 11,550
• Mixed Crops	• 6.0%	• 8,250
• Mixed Crops and Livestock and Other	• 2.4%	• 3,300
Specialist Tillage	3.4%	4,675
All Farms	100%	137,500

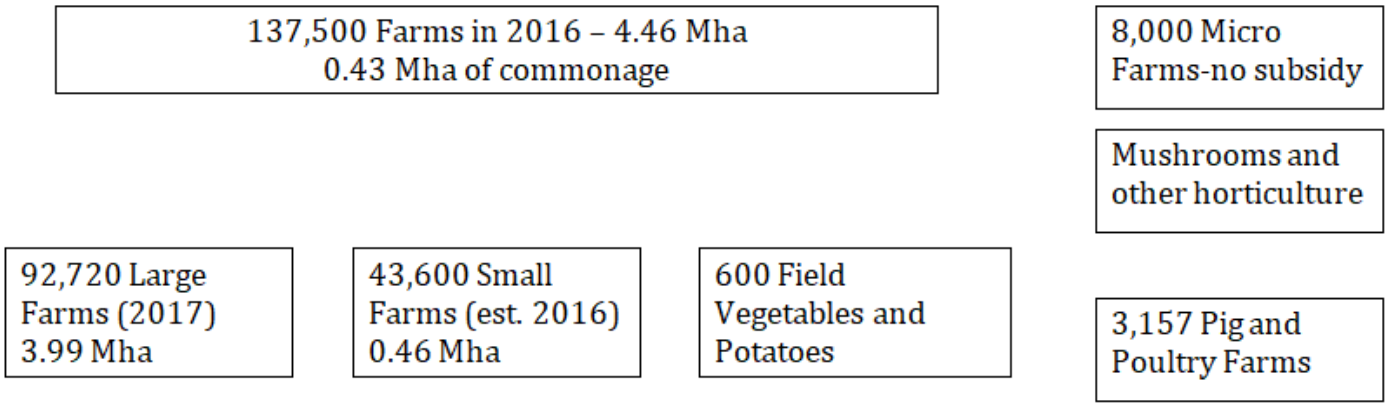
Data from CSO Farm Structure Survey 2016



Data from CSO Farm Structure Survey 2016

Every Year Teagasc produce the National Farm Survey which looks at the economic activity of a sample of different types of Large farms. This survey classifies farms with a Standard Output (SO) of over €8,000 as Large farms. Standard output (SO) is the average monetary value of the agricultural output at farm-gate prices. The SO excludes direct payments (subsidies), VAT and taxes on products. Farms with a Standard Output (SO) of €8,000 or less are defined as Small farms. These farms are surveyed every five years. According to Teagasc: "Little information is available on a further **8,000 'micro' farms**, which are not in receipt of direct payments. It is assumed that most of these are very small-scale or 'hobby' farms."

The latest Teagasc Report estimates 92,720 Large Farms with a total land area of 4Mha. Given that the total land area is 4.46 Mha this leaves 0.46 Mha for small farms (2015 estimate was 0.85 Mha). A summary of the breakdown of farms is shown below based on the Teagasc 2019 and CSO 2016 reports.



The below table summarises the Large Farm Teagasc NFS preliminary information for 2018 and shows that **beef and sheep farms make up 73% of the large farms in Ireland** and occupy 64% of the large farm land or 2.54 Mha**.** These tables below are indicative and seem to have some inaccuracies, for example the farm numbers given above by Teagasc don't add up correctly to 92,720 nor do the land areas add up exactly.

Large Farm Type	Average Size	Income / ha	Subsidy % FFI	No. of Farms	% of Farms	Land Area Mha	% Land
Dairy	58	€1,049	34%	16,146	17%	0.94	23%
Cattle Rearing	31	€269	158%	25,901	28%	0.80	20%
Cattle Other	37	€387	113%	28,119	30%	1.04	26%
Sheep	49	€281	137%	14,322	15%	0.70	18%
Tillage	61	€697	54%	6,879	7%	0.42	11%
All Farms	43	€542	74%	92,720	100%	3.99	100%

Large Farm Information, 2018 from Teagasc

Assuming small farms are 60% beef and 40% sheep enterprises gives us the below table.

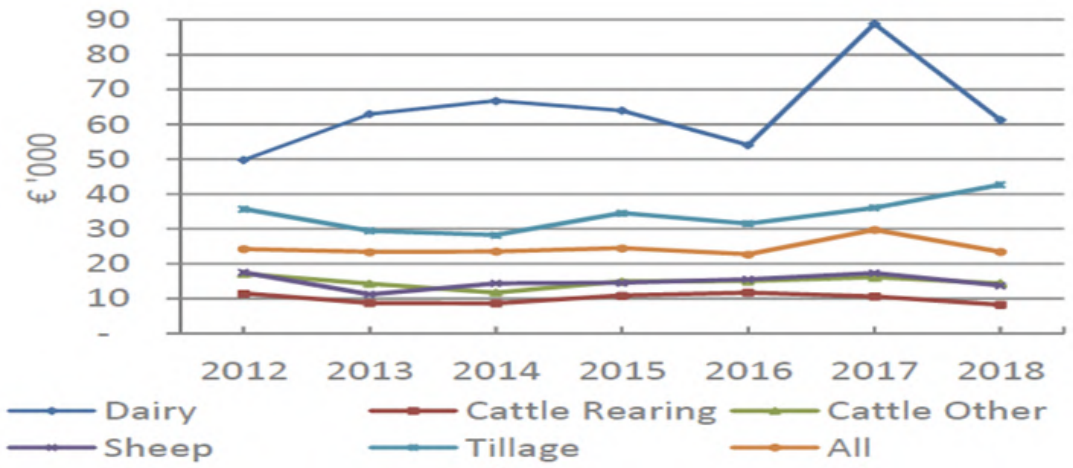
Farm Type	Large Farms	Land Mha	Small farms	Land Mha	No of Farms	%	Land Mha	%
Dairy	16,146	0.94	0	0	16,146	12%	0.94	21%
Cattle Rearing	25,901	0.80	26,870	0.34	80,890	59%	2.18	49%
Cattle Other	28,119	1.04						
Sheep production	14,322	0.70	17,850	0.22	32,172	23%	0.92	21%
Tillage	6,879	0.42	0	0	6,879	5%	0.42	9%
Rounded Totals	92,780	3.90	44,720	0.56	137,500	100%	4.46	100%

To summarise, large farms occupy 4 Mha and small farms occupy 0.46 Mha to give a total agricultural land area of 4.46 Mha. Beef production occupies 2.18 Mha, sheep production 0.92 Mha, Dairy 0.94 Mha and tillage 0.42 Mha. Beef and sheep production make up 82% of all farms and occupy 70% of agricultural land (3.1 Mha). These farms receive an average of 113 - 219% of income from subsidies across both large (2018) and small (2013) farms.

6.3 The Economics of Large Farms

Family Farm Income per Farm (FFI) is defined and calculated by Teagasc by deducting all farm costs (direct and overhead) from the value of farm gross output. Unpaid family labour is not included as a cost. FFI therefore represents the financial reward to all members of the family who work on the farm for their labour, management and investment. It does not include income from non-farming sources and so may not be equal to household income. The average FFI for 2018 was **€23,306** - a 26% drop on 2017. **On average 74% of income was from Farm Subsidies.** The main reason for the decrease was the increased need for concentrates due to the low grass growth rates during the summer drought of 2018 and the increase in the cost of contractors. This average conceals major income differences across the various farm types. The below NFS image shows the FFI for different farm types ranging from €61,273 for Dairy to €8,318 for Beef - Cattle Rearing farms. It also shows the percentage change in FFI from 2017 to 2018.

The below graph shows how farm incomes have varied over the past six years with 2017 showing an unusually volatile increase in Dairy incomes.



Total payments made to farmers were estimated to be €1.8 billion in 2017. This figure includes subsidies in agriculture such as the Basic Payments Scheme, which is the main subsidy, Areas of Natural Constraint, GLAS and disease compensation payments, and also payments such as Forestry Premia, and the Targeted Agricultural Modernisation Scheme.

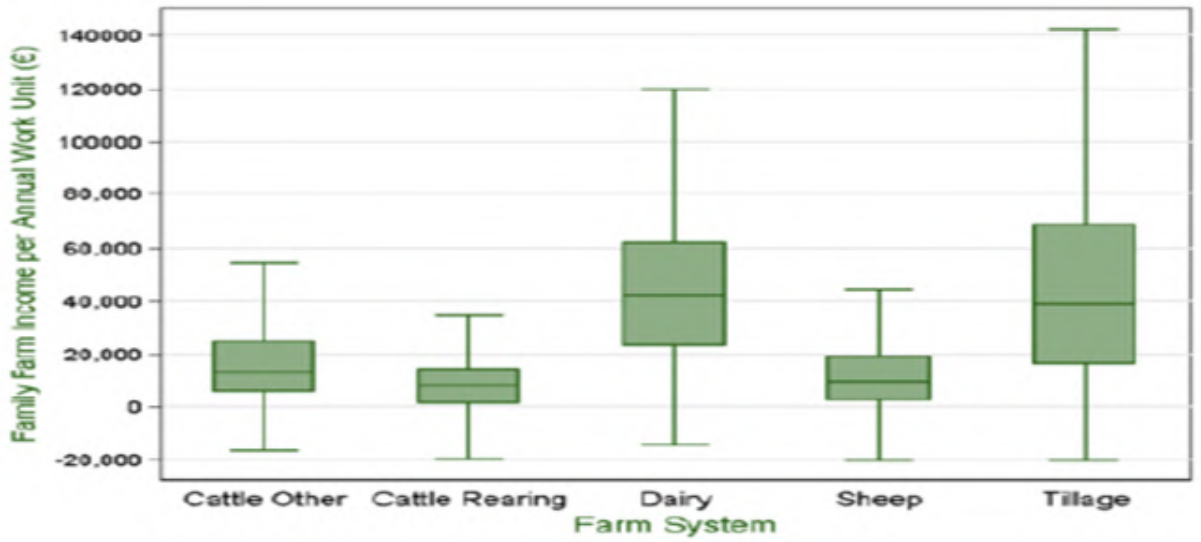
In 2018 the average total payment received was €17,292 per farm and this accounted for **74% of average farm income**. There are major differences in subsidies between the different farm types. Direct payments accounted for 34% of dairy farm income, while accounting for 113% of cattle other income, 158% of cattle rearing income, 137% of sheep farm income and 54% of tillage farmers incomes as shown below.

	DPs	FFI contribution
Dairy	€21,131	34%
Cattle Rearing	€13,109	158%
Cattle Other	€16,257	113%
Sheep	€18,812	137%
Tillage	€23,134	54%
All	€17,292	74%

Value of Direct Payments and Contribution to Income in 2018: Teagasc, 2019

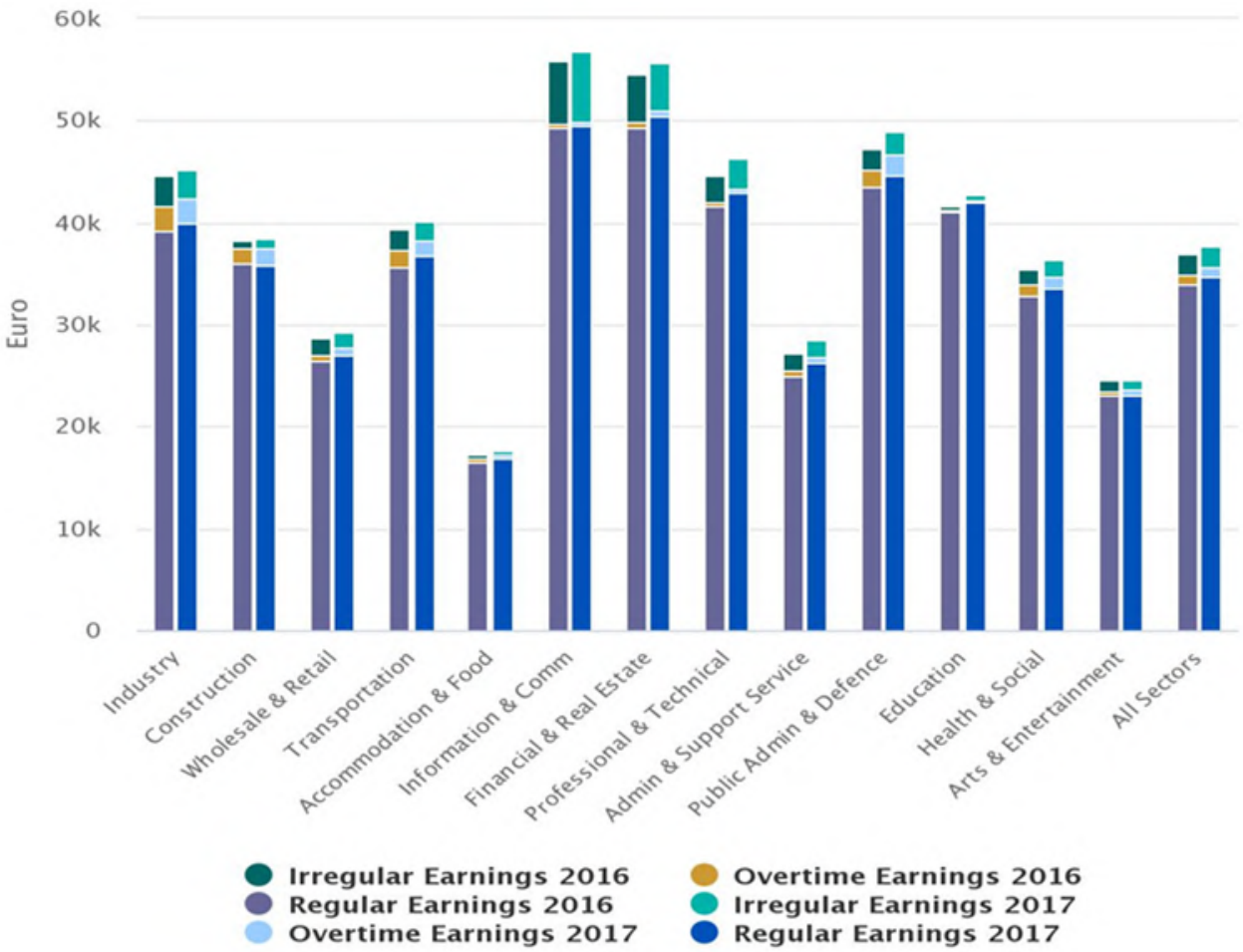
In 2018 73% (68,342) of large farms occupying 2.54 Mha received 113-158% of their income from subsidies. It's hard to believe that nearly three quarters of large farms generate no income and in fact operate at a substantial loss after costs are deducted. Beef and Sheep farming systems have failed as economic enterprises and should be considered economically unviable businesses. Even tillage farms rely on a subsidy of 54% and dairy farms a subsidy of 34%.

On average, there was one unpaid family labour unit employed on farms in 2018. The amount of unpaid labour supplied was highest on Dairy farms at 1.4 labour units and lowest on Cattle Other farms at 0.88. The below diagram presents farm income per labour unit. Proportionately, hours worked (both family and hired) are highest on Dairy farms and when FFI is adjusted for same, a median FFI of below €42,432 is reported, with half of all Dairy farms (the green shaded box) earning between €23,000 and €62,000 approximately.



System Avg. FFI per Annual Work Unit 2018

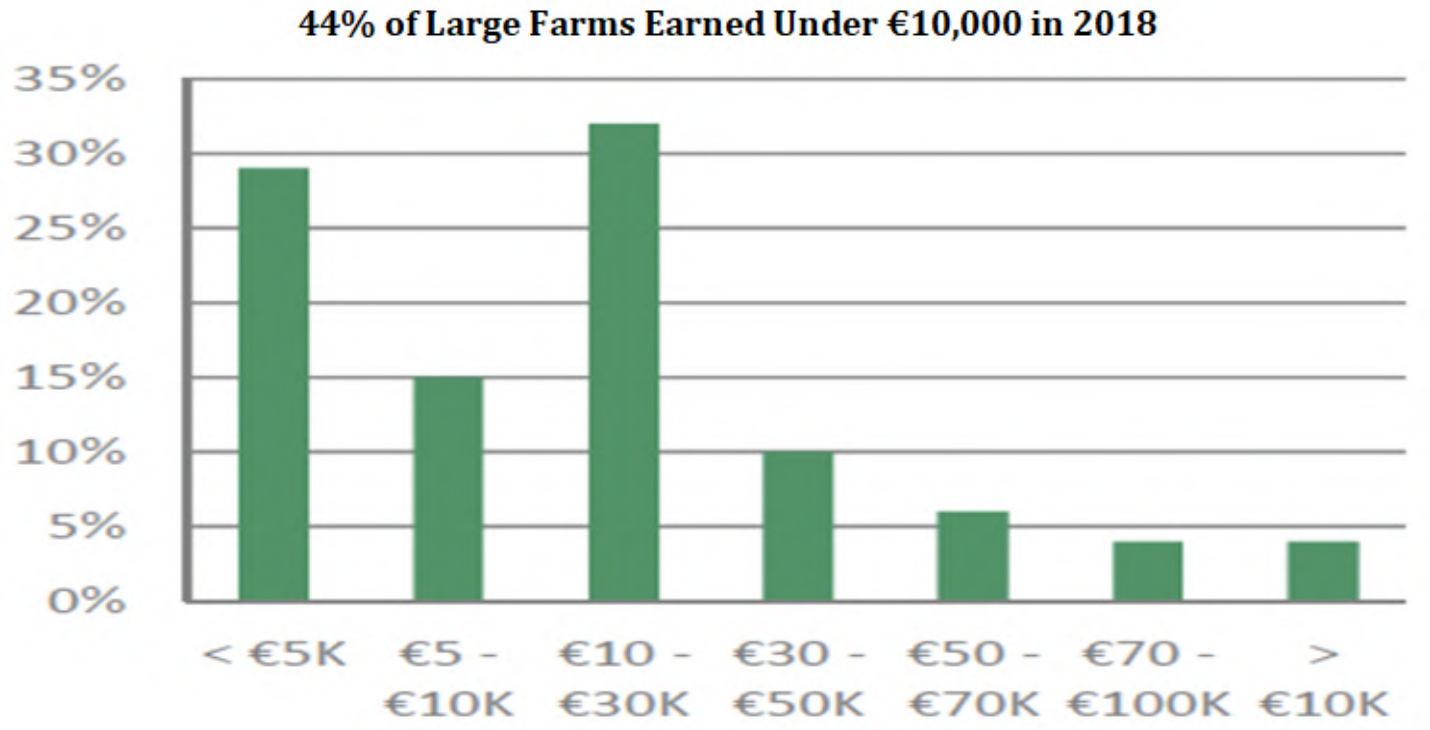
Beef and sheep farmers are not earning a living wage and earn well under half the average industrial wage. The below diagram shows the average incomes for different economic sectors in Ireland in 2017.



The average annual industrial sector earnings increased by 2% to €37,646 in 2017, from €36,920 in 2016. For full-time employees in 2017 wages were €46,402, while part-time employees wages were €17,059. The average FFI for 2018 was **€23,306**. The below table compares the average industrial wage of €37,646 with the median income of dairy farmers and the FFI of other farm types who on average have one employed person. It needs to be remembered that 78% (2017) of large farm households have one or more additional income sources.

Large Farm Type	Income	No. of Farms	Farm Income as % of Industrial Wage
Dairy	€42,432	16,146	113%
Cattle Rearing	€8,318	25,901	22%
Cattle Other	€14,408	28,119	38%
Sheep	€13,769	14,322	37%
Tillage	€42,678	6,879	113%
Average	€23,306	92,720	62%

73% of the Large Farms in Ireland are cattle and sheep farms whose FFI is 22-38% of the industrial wage. In Ireland any adult earning less than €13,022 annually is considered to be living in **poverty**.



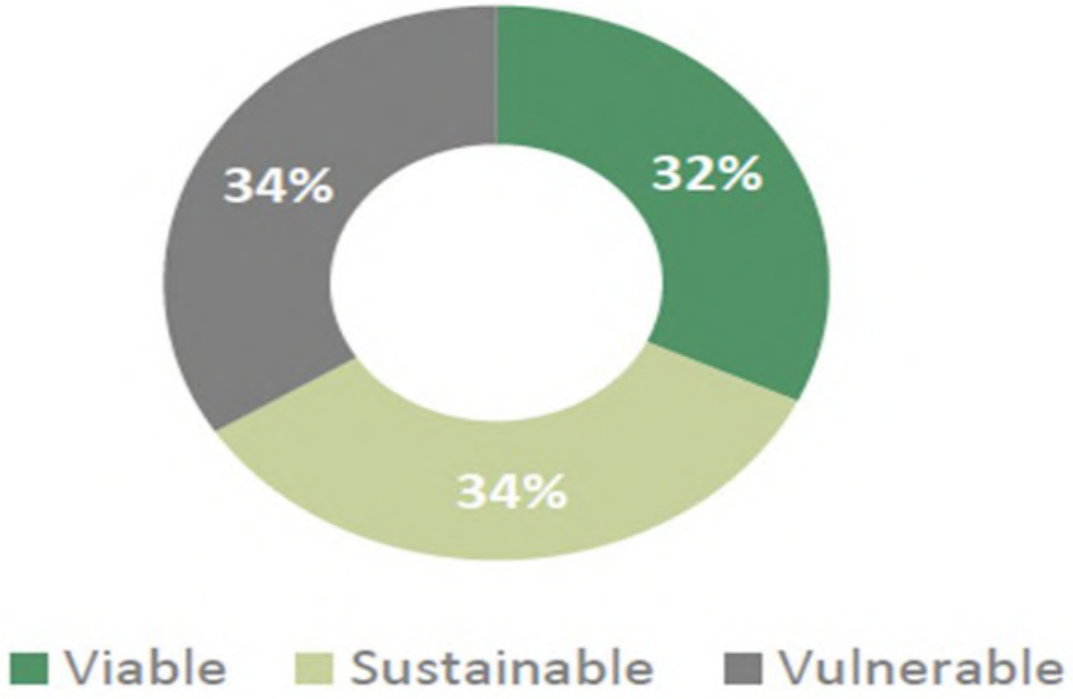
Average Large Farm Income Distribution 2018: Teagasc 2019

29% of farms across systems had a farm income of less than €5,000 in 2018. A further 15 percent earned between €5,000 and €10,000. If they were dependent on farming alone then the incomes of 40,800 (44% of large farms) farmers is actually below the poverty line. Land Management for Biodiversity and Climate Mitigation and Flood and Water Quality Protection is much more valuable to society than beef and sheep production. Returning this land to Ecosystem Services will increase the income of all the Beef and Sheep Farmers by 13 – 58%.

Economic Viability of Large Farms according to Teagasc National Farm Survey

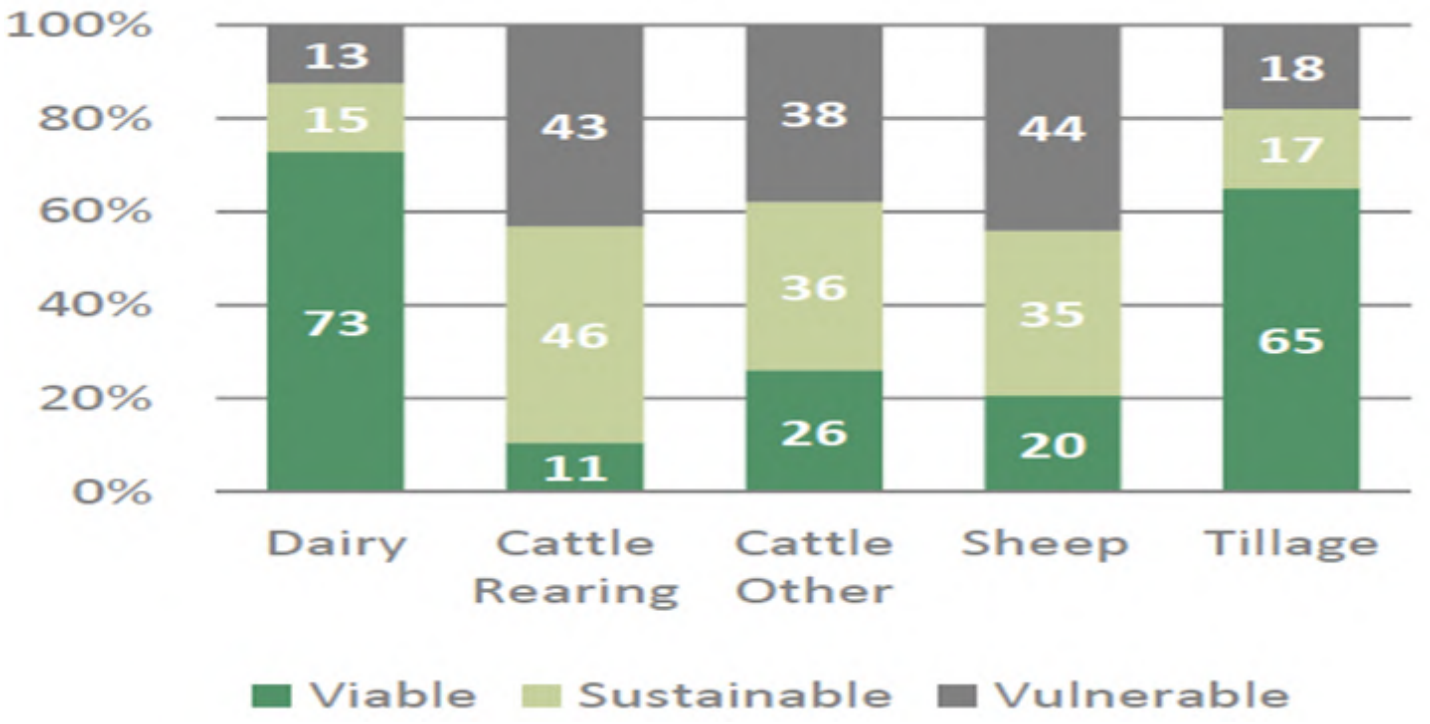
- Viable - A farm is defined as economically viable if it can remunerate family labour at the average agricultural wage, and provide a 5% return on non-land assets.
- Sustainable - These farms are not economically 'viable' on the basis of their income from farming, but they are classified as sustainable due to off-farm employment of the farm holder and/or spouse.
- Vulnerable - The income from farming is not sufficient to make these farms economically viable, and they have no off-farm employment. About half of these farm holders are aged over 65. These farmers could be seen as being in a period of transition from active farming towards retirement and farm transfer – whether through sale, long-term leasing or transfer to a family member. However, the number of such farms has not shown any significant change over the last decade (Teagasc, 2013). To reflect the reality on the ground the term vulnerable should be replaced by the more truthful term 'Living Below the Poverty Line.'

The below diagram shows average farm viability for larger farms. Teagasc's NFS found that 32% of Irish farms were classified as viable in 2018, with a further 34% classified as sustainable as they had an additional off-farm income, while the remaining 34% were deemed to be economically vulnerable. This shows that 68% of farms can't provide a full household income even with the current massive level of subsidies.



Viability of Irish Farming 2018: Teagasc 2019

The below diagram shows the viability of the different farming systems with beef and sheep farms being the least profitable.



Teagasc Viability of Farming by System 2018: Teagasc 2019

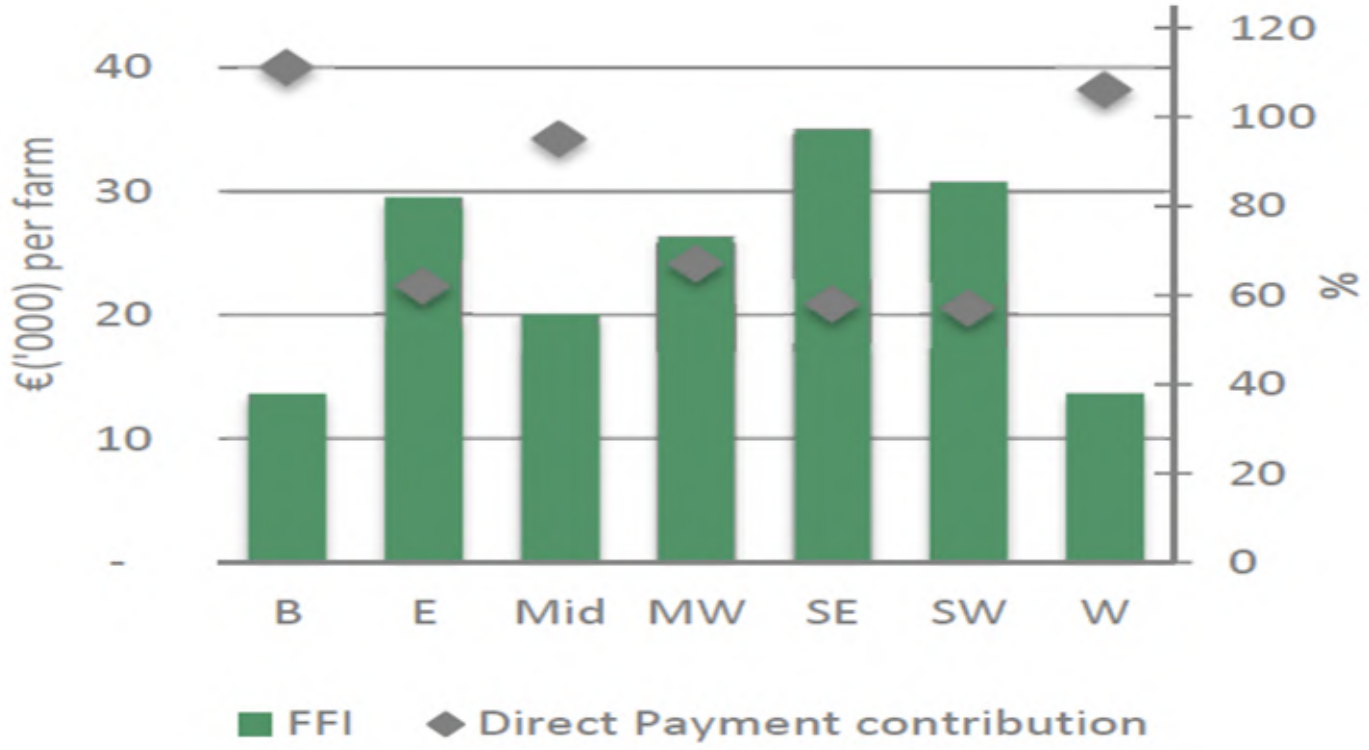
Land Area of Viable Farms

In the below table we have applied the percentage of viable, sustainable and vulnerable farm types to the land area to give an estimate of the viable large farm land area.

Farm Type	% Via	Viable Farms	Viable Area Mha	% Sus	Sustain-able Farms	Sustain. Area Mha	% Vul	Vulner-able Farms	Vulner-able Area Mha
Dairy	73%	11,787	0.68	15%	2,422	0.14	13%	2,099	0.12
Cattle Rearing	11%	2,849	0.09	46%	11,914	0.37	43%	11,137	0.35
Cattle Other	26%	7,311	0.27	36%	10,123	0.37	38%	10,685	0.40
Sheep	20%	2,864	0.14	35 %	5,013	0.25	44%	6,302	0.31
Tillage	65%	4,471	0.27	17%	1,169	0.07	18%	1,238	0.08
Total	32%	29,670	1.28	34%	31,525	1.36	34%	31,525	1.36

To put these results in context, **there are just 30,000 Viable Large farms in Ireland** occupying 1.28 Mha. This does not take account of smaller farms with a standard output of less than €8,000 which we look at below. Data is collected on these farms every five years and most recently in 2015, when only 17% of small farms were found to be viable. The Teagasc Report continues: "The regional figures are stark, with 44 per cent of farms in the South classified as viable compared to only 17 per cent in the Northern and Western region. The equivalent figure in the Eastern and Midland area is 35 per cent."

The below diagram shows the average incomes in different regions as well as the percentage contribution of subsidies to FFI. Direct payments account for 111% of FFI in the Border, 106% in the West, and 95% in the Midlands region. Although much lower in percentage terms, direct payments account for a significant proportion of farm income across the other regions also, ranging between 57 and 67 per cent.



In 2017 just over 35,000 Viable large farms occupied approx 1.7 Mha. In 2018 this dropped to just under 30,000 Viable Large Farms on 1.28 Mha.

6.4 The Economics of Small Farms

According to the CSO FSS "43,600 farms (31.7%) had a Standard Output of less than €8,000 per annum" down from 72,830 in 1991. The Teagasc Small Farm NFS in 2015 states that small farms are fully dependent on subsidies which range from **173% to 219% of FFI.** Small farms occupied just 0.56 Mha of agricultural land in 2016. 60% of small farms are in the BMW region. Just under 85% of farms with less than 10 hectares had a standard output of less than €8,000 in 2016. Just under half (46%) of all Specialist Sheep farms had a standard output of less than €8,000. Almost 43% of farms in Ireland were less than 20 hectares in size.

Cattle farming is the predominant enterprise on Small Farms, with 61% of Small Farms categorised as Cattle Farms. Although small in scale individually, and contributing very little to agricultural output, such farms account for almost 560,000 hectares of agricultural land. **Average Family Farm Income for Small Farms in Ireland in 2013 was under €3,000.**

Average Family Farm Income
Cattle and Sheep Farms 2015

	Larger Farms	Small Farms
Gross Output	46,235	11,351
(of which direct payments)	15,217	5,474
Total Costs	31,265	8,434
(of which direct costs)	15,112	3,304
(of which overheads)	16,153	5,131
Family Farm Income	**14,970**	**2,917**

Teagasc Small Farm Survey, 2015

Average FFI on Small Farms was just 20% that of Larger Farms in 2015. The average Small Farm is 14 hectares in size. The average **FFI of small farms was less than €2,917 in 2015. Small farms were in receipt of** €220 million in payments in 2015. Depending on the Farm System, the share of direct payments range between **173% of FFI** for small beef farms to as much as **219% of FFI** for small sheep farms**.**

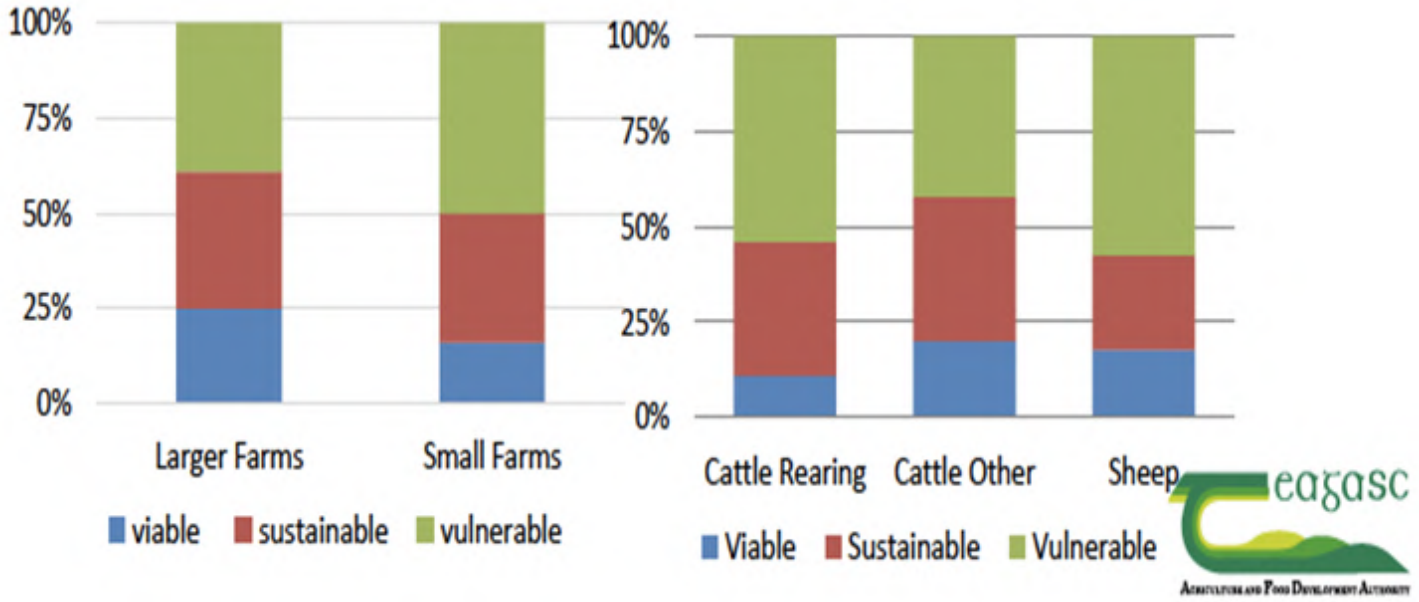
	2015 Larger Farms			2015 Small Farms		
	Direct Payments	Per ha	Contribution to Income	Direct Payments	Per ha	Contribution to Income
	€		%	€		%
Cattle Rearing	13,158	369	102	5,796	374	173
Cattle Other	15,478	407	95	5,543	405	180
Sheep	17,016	342	108	5,082	383	219

Teagasc Small Farm Survey, 2015

Given the extremely high levels of subsidies for small farms we would recommend that small farms should immediately be given the opportunity to cease trading as beef and sheep enterprises and instead be paid for vital ecosystem services. This would see the conversion of 43,600 small farms to ecological enterprises. This could potentially increase the income of small land owners from €2,917 to €5,474 (average small farm subsidy) and their time would be spent restoring the ecosystem services on their land. This could potentially free up 0.56 Mha of land for native forestry, grasslands, and wetlands.

Economic Viability of Small Farms

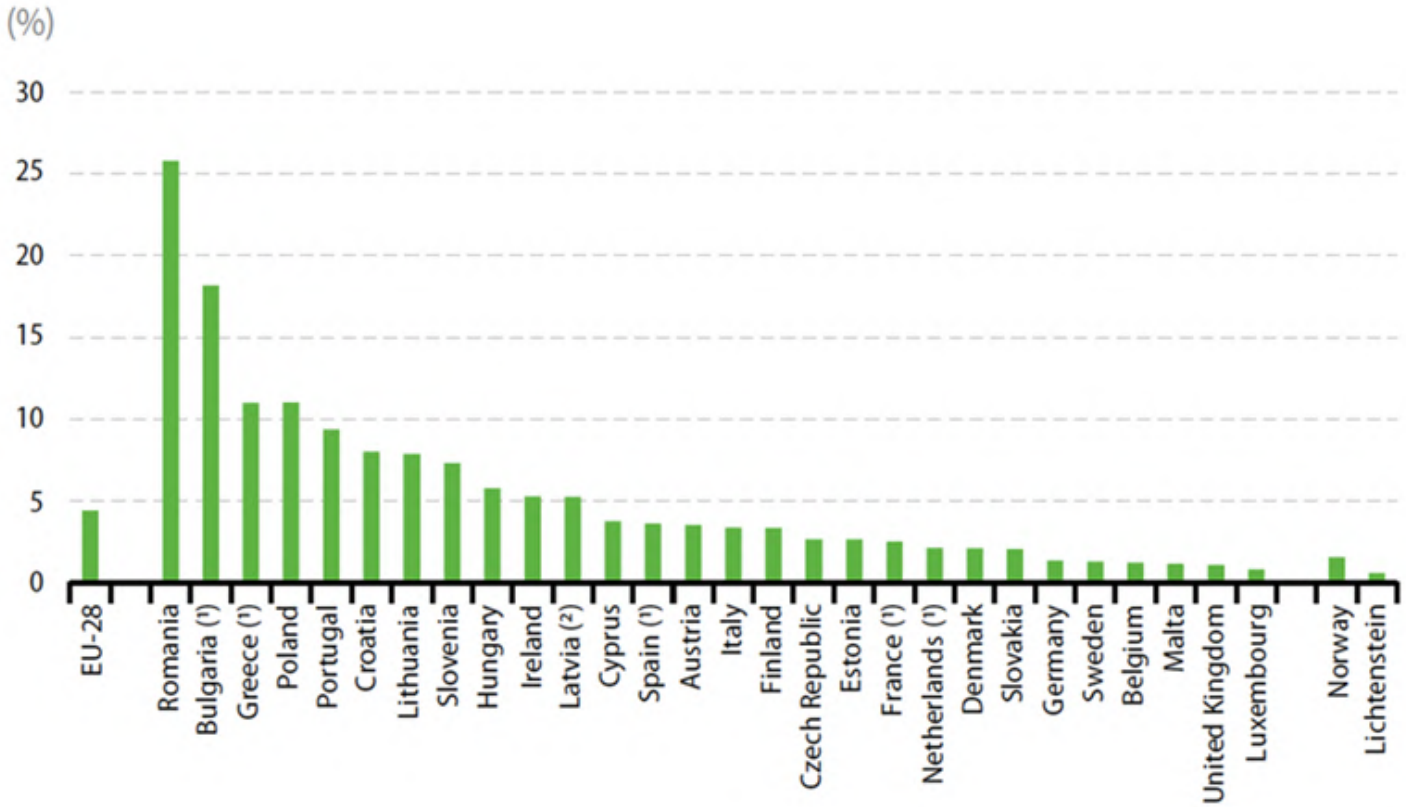
Over 80% of all Small Farms are not economically viable businesses. Sheep farms are the largest vulnerable group amongst small farms (58%). Only 11% of Cattle Rearing Farms were viable, the figure on Cattle Other Farms was 20%.



In 2015 88% of small farms were in receipt of an off-farm income source, either an off-farm job or pension or social welfare payment. Given the extremely high levels of subsidies for small farms we have assumed that the land currently occupied by small farms should be restored to native forests, grasslands and/or wetlands.

6.5 Employment in Ireland's Agri-Food Sector

As economies develop manufacturing, industrial and service sectors the number of people employed in agriculture drops because wages and value added are much higher in other sectors of the economy. The below graph shows EU percentage employment in agriculture.



The below CSO table shows the number of jobs in different Irish economic sectors in 2016.

	Employment in Ireland by Economic Sector 2016	Total	%
1	**Agriculture, forestry and fishing**	**116,766**	**5.8**
2	Industry	255,848	12.7
3	Construction	137,324	6.8
4	Motor vehicles and motorcycles	275,161	13.7
5	Transportation and storage	95,203	4.7
6	Accommodation and food services	146,221	7.3
7	Information and communication	84,983	4.2
8	Financial, Insurance and Real estate	101,960	5.1
9	Professional, Scientific and Technical	115,397	5.7
10	Administrative and Support services	70,345	3.5
11	Public admin. and defence; compulsory social security	105,372	5.2
12	Education	151,470	7.5
13	Human health and social work activities	251,964	12.5
14	Other NACE activities	106,886	5.3
	Total:	2,014,900	100

Source: Eurostat LFS, CSO QNHS

According to the CSO Agriculture, Forestry and Fishing combined employ 104,115 men and 12,651 women to give a combined total of 116,766 people or 5.8% of the workforce.

These figures differ from the DAFM figures, which we present below. According to the Department of Agriculture employment in primary agriculture, forestry and fishing was 112,500 people, 5% of the employment market. Food, fish and timber processing accounted for a further 61,900 jobs or 2.9% of total employment in 2017. Beverages are said to employ 5,200 people.

	2017	% of Total
All persons in employment	2,194,400	100.00%
of which		
Agri- food sector	174,400	7.90%
Agriculture, forestry & fishing	112,500	5.04%

Source: CSO, Labour Force Survey, 2017

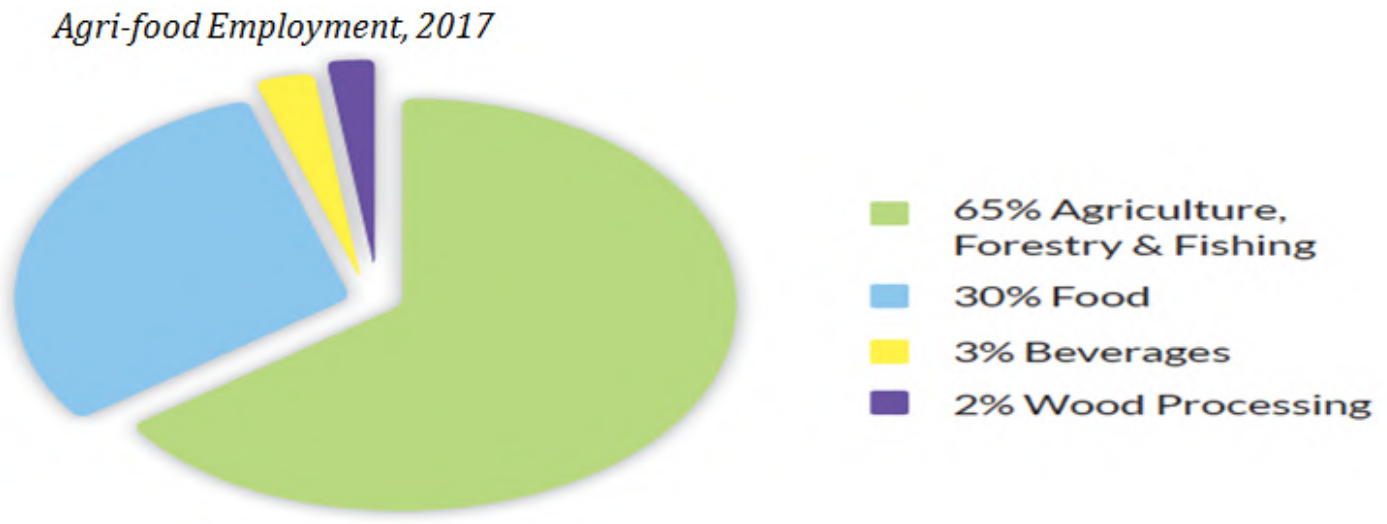
Agriculture, forestry and fishing employed 112,500 in 2017. The DAFM estimate that Forestry employment is c. 12,000 jobs. So I have assumed 6,000 people work in primary forestry production. Below is the DAFM employment estimate for the fishing industry.

	2016			2017		
	Full Time	Part-Time	Total	Full Time	Part-Time	Total
Fisheries	2,672	789	3,461	2,620	741	3,361
Aquaculture	558	1,269	1,827	657	1,255	1,912
Processing	2,415	1,534	3,949	2,478	1,510	3,988
Ancillary			1,000			5,367
Grand Total			10,237			14,628

The fishing industry employs 5,273 (full time and part time) in primary production (fisheries and aquaculture) and another 3,988 in processing. We summarise these figures below.

	Agriculture	Beverages	Fishing	Forestry	Total
Primary	101,227		5,273	6,000	112,500
Processing	46,712	5,200	3,988	6,000	61,900
	147,939	5,200	9,261	12,000	174,400

In 2017 primary agriculture employed 5% of the workforce and food processing a further 2.3% of the workforce.



Source: CSO, Labour Force Survey, 2017

Off-Farm Income

According to the 2017 NFS: "Just over half (51%) of large farm households had an off-farm employment income source in 2017, a 2 percentage point increase from 2016. The increase is reflective of an increased proportion of both farm holders (31%) and spouses (34%) employed off-farm in 2017. A further 27% of households are in receipt of a pension." In 2017 78% (up 1% from 2015) of large farms were dependent on an off farm source of income. In 2015 88% of small farms were in receipt of an off-farm income, either an off-farm job or pension or social welfare payment.

Proportion of Farms with off-farm income 2015

Farmer/Spouse	Off-Farm Job	Pension	Unemployment/ Farm Assist	Job/Pension/Social Assistance
Small Farms	45%	39%	20%	88%
Larger Farms	50%	26%	8%	77%

Teagasc Small Farm NFS 2015

Age Profile of Farmers

According to the CSO 2016 FSS more than half of farm holders were aged 55 or over, with 30% of farm holders over 65 (41,200 farms), and 5.4% under the age of 35 years holding just 7,400 farms. This is primarily due to the low wages on beef and sheep farms, which do not come close to competing with income levels in industrial or commercial sectors.

6.6 Conclusions

1. In 2016 Ireland exported €13.2 billion (11% of exports) of agri-food products and imported just over €9 billion (12% of imports) of agri-food products.
2. The primary agricultural, fisheries and forestry sectors contribute 1.6% of National Gross Value Added while the overall agri-food sector contributes 5.5%.
3. There are 137,500 farms in Ireland. Large farms account for 4 Mha and small farms for 0.46 Mha. The average FFI for Large Farms in 2018 was **€23,306**. **On average 74% of income was from Farm Subsidies** with an average payment per farm of **€17,292**.
4. 44% (40,800) of large farms earn less than €10,000 a year.
5. **In 2018 73% (68,342) of large farms on 2.54 Mha received 113-158% of their FFI from subsidies.** This large farm income was just 22-38% of the average industrial wage.
6. 51% of large farms were in receipt of an off-farm income source.
7. In 2018 Direct payments account for 111% of FFI in the Border, 106% in the West, 95% in the Midlands region for Large Farms.
8. In 2018 there were only 30,000 Viable large farms in Ireland on approx 1.28 Mha.
9. Small Farms received 173 – 219% of FFI from subsidies in 2015. 88% of small farms were in receipt of an off-farm income source.
10. In 2015 average income for 52,300 (43,600 in 2018) Small Farms was under €3,000.
11. 40,800 large farms earn less than €10,000 a year and 43,600 small farms earn an average of under €3,000. **So 62% of all farms earn a FFI that is well below the poverty line.**
12. In 2017 primary agriculture employed 101,227 people (5% of the workforce) and food processing a further 46,712 (2.3% of the workforce).
13. A third of farm holders are over 65 years of age. The average farmer age is 56.
14. 78% (2017) of large farms and 88% of small farms (2015) were dependent on an off farm source of income, either an off-farm job or pension or social welfare payment.
15. Beef and sheep production make up 82% of farms and occupy 70% of agricultural land (3.1 Mha). These farms receive an average of 113 - 219% of their income from subsidies across both large (2018) and small (2013) farms.

Chapter 7: Food Security

Chapter 7: Food Security

This section explores Ireland's current Food Security Status and the following questions:

- How would the changes in agriculture impact food security?
- How would a VAS produce adequate food calories for the Irish population?
- What impact would a VAS have on exports of food to other countries?

Based on the data from the European Commission, the total gross production of meat in the EU-28 rose by 12.7% between 2000 and 2017, from 41.9 Mtonnes to 47.3 Mtonnes. While not finalised, predictions from 2018 data indicate a further rise to 48 Mtonnes. Sectorally, the increase occurred mainly in poultry and pork production. In the beef and veal sector, production decreased until 2013, after which it started to increase again.

In 2016 Ireland exported €13.2 billion and imported just over €9 billion of agri-food products (including beverages and fertilisers). It's worth repeating that this is much greater than our total energy imports which were €4.7 Billion in 2016.

	Product Categories listing Agri-Food Related Products CSO Data for 2016		Exports € millions	Imports € millions
	0	Live animals other than animals of Division 03	447	296
	1	Meat and meat preparations	3,844	978
	2	Dairy products and birds' eggs	2,397	784
	3	Fish, crustaceans, molluscs and preparations thereof	605	291
	4	Cereals and cereal preparations	416	1,096
	5	Vegetables and fruit	299	1,251
	6	Sugars, sugar preparations and honey	158	376
	7	Coffee, tea, cocoa, spices and manufactures thereof	365	591
	8	Feeding stuff for animals (excluding unmilled cereals)	323	781
	9	Miscellaneous edible products and preparations	2,500	713
	11	Beverages	1,356	816
	21	Hides, skins and furskins, raw	134	0
	22	Oil seeds and oleaginous fruits	8	33
	27	Crude fertilisers & minerals (excluding coal, petroleum, etc)	130	170
	29	Crude animal and vegetable materials nes	139	211
	41	Animal oils and fats	81	20
	42	Fixed vegetable fats and oils	11	223
	43	Animal or vegetable fats and oils, processed; waxes	1	20
	56	Fertilisers (other than those of Division 27)	7	368
		Total:	**€13,221**	**€9,018**
		Beverages:	€1,356	€781
		Animal Based Products:	€7,508	€2,369
		Plant Based Products:	€1,580	€4,351
		Both Animal and Vegetable Products:	€2,640	€944

Ireland has high food security in terms of meat and dairy products. Bord Bia estimate self-sufficiency of beef, mutton and pork at over 650%, over 360%, and around 190% respectively. Remarkably despite this overproduction Ireland still imports billions of euros of meat and dairy products as shown below. At the same time Ireland has a high level of food **insecurity** for grains/cereals, fruits, vegetables, legumes and nuts and seeds. Ireland is also highly dependent on the import of animal feeds.

	Product Categories listing Meat Based Related Products CSO Data for 2016		Exports € millions	Imports € millions
	0	Live animals other than animals of Division 03	447	296
	1	Meat and meat preparations	3,844	978
	2	Dairy products and birds' eggs	2,397	784
	3	Fish, crustaceans, molluscs and preparations thereof	605	291
	8	Feeding stuff for animals (excluding unmilled cereals)	323	781
	21	Hides, skins and furskins, raw	134	0
	41	Animal oils and fats	81	20
		Animal Based Products:	€7,831	€3,150

7.1 How many People are Currently Fed by Irish Agriculture

Below is a breakdown of the yields for 2017 (from CSO - Crop Yield and Production by Type of Crop) and how many people could be fed by Irish Agricultural Production.

Crop	Annual Yield Tonnes/Yr	Land Area hectares	Food Energy KCal/kg	Energy Yield T Kcal per Year	Persons fed per Year
Spring Wheat	55,200	6,800	3,390	0.19	256,340
Oats	205,000	24,400	3,890	0.80	1,092,397
Beans and Peas	90,200	13,700	3,470	0.31	428,759
Oilseed Rape	41,700	10,100	8,500	0.36	485,548
Potatoes	412,400	9,200	770	0.32	434,997
	(CSO data)	64,200			2,698,041

In 2017 304,700 ha was used to grow crops but only 64,200 ha was used to grow crops that are fed directly to people. In 2017 vegetables, fruit and horticulture production occupied 4,700 ha to give a total of approx. 310,000 ha for crops, fruit and horticulture. In 2017 farmers also grew Other Cereals, Maize Silage, Sugar Beet and Other Crops on 55,300 ha for animal feed. The land area growing food for direct human consumption is under 2% of Ireland's Agricultural Land. The production of animal products in Ireland in 2017 is below.

Crop	Annual Yield Tonnes/Yr	Food Energy KCal/kg	Energy Yield T Kcal per Year	Persons fed per Year
Beef	588,000	2,500	1.47	2,013,699
Chicken	146,000	2,390	0.35	478,000
Pork	283,000	2,420	0.68	938,164
Sheep meat	61,000	2,940	0.18	245,671
Milk	527,000	650	0.34	469,247
Butter	199,000	7,170	1.43	1,954,562
Skim Milk	117,000	3,600	0.42	576,986
Cheese	207,000	4,020	0.83	1,139,918
Eggs (No)	144,000,000	65 (per egg)	9.36	12,821,918
				20,638,164

Data from the CSO and Bord Bia

This shows that in 2017 Ireland produced enough calories from plant foods to feed 2.7 million and enough calories from animal foods to feed 20.6 million, to give a combined production total of sufficient food calories to feed 23.3 million people on 4.9 Mha. We imported enough food calories in feed grain, legumes and oil seeds to feed 15 million people.

If we wanted to produce enough plant based calories to feed 23 million people we could do so on 0.58 Mha as shown below. I have used the productivity of Oil Seed Rape and Potatoes as samples for different oil seed and vegetable crops.

Crop	Land Area hectares	Annual Yield Tonnes/Yr	Food Energy KCal/kg	Energy Yield T Kcal /Year	Persons fed per Year
Beans and Peas	200,000	1,320,000	3,470	4.58	6,274,521
Grains	150,000	1,260,000	3,390	4.27	5,851,233
Oilseed Rape	100,000	410,000	8,500	3.49	4,773,973
Potatoes	130,000	5,837,000	770	4.49	6,156,836
	580,000				23,056,562

In order to understand why we need so much less land for plant based foods, it is helpful to see how many people can be fed from one hectare in Ireland on a plant-based diet versus a meat-based diet.

Comparing People fed per Hectare by Irish Plant versus Animal Production

Meat production and in particular beef production are incredibly inefficient. Looking at the average yields for Ireland we see that a plant based diet produces enough grain and vegetables from a hectare to feed 30 people for one year, or enough beans and peas to feed twenty people for a year, but only enough beef for one person.

Item	Yield/ha kg	KCal/ Kg	Million kCal/ha	Person fed/ ha/yr
Wheat – total	10,200	3,390	34.58	47
Oats – total	8,400	3,890	32.68	45
Barley – total	8,400	3,540	29.74	41
Beans and peas	6,600	3,470	22.90	31
Potatoes	44,900	770	34.57	47
Beef	260	2506	0.65	1

Yields from CSO for 2017and Calorie Content from Google and USDA.

Assuming a stocking density of 1.7 cattle per hectare (in 2018 average stocking rate was 1.13 – 1.36) raised for two years weighing 600 kg yielding 510 kg / ha /yr with 250 kg waste.
Assuming 4 Kcal per gram of protein and carbohydrates and 9 Kcal per gram of fat.
Assuming 2,000 kcal per person per day.

From this we can see that a plant based diet can feed 31-47 times the number of people that would be fed on a beef diet, based on Irish Agricultural Yields for 2017.

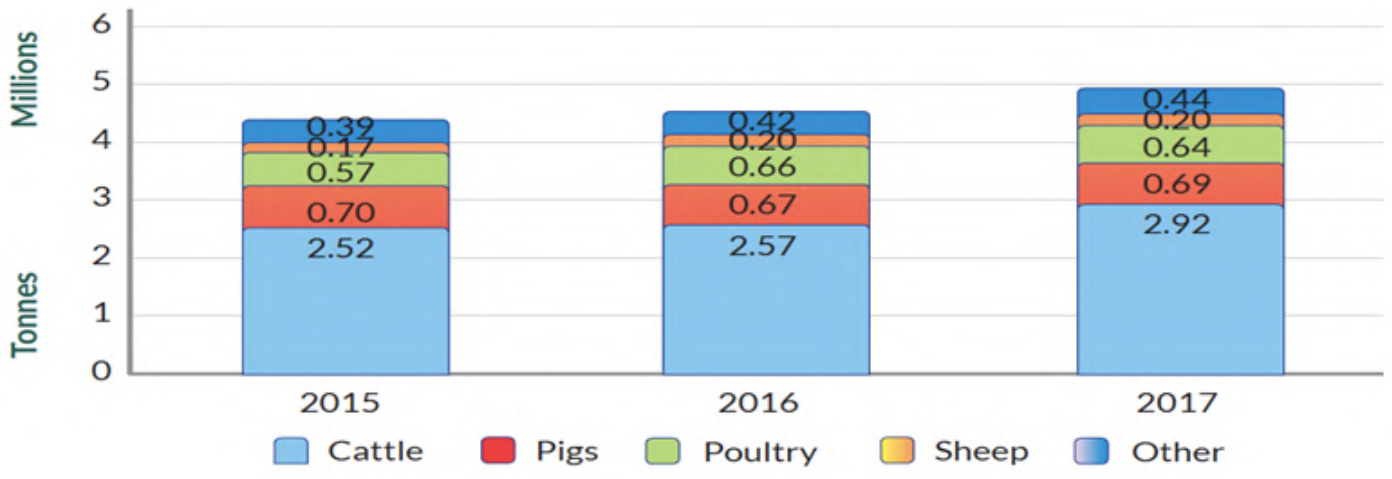
7.2 Food Calories Lost in Meat Production

How much food calories do farm animals eat to produce meat and dairy products. Below is an estimate of the amount of food fed to farm animals. In Ireland there are 4.1 million hectares of pastures and 0.44 million hectares for rough grazing. Assuming a yield of 10 tonnes of dry matter grass per hectare in pastures yields 41 million tonnes, and assuming 2.5 tonnes per hectare for rough grazing yields 1.1 million tonnes, these combine to give 42 million tonnes of fodder. This is supplemented with 4.9 million tonnes of compound feeds (2017).

Animal Feedstuffs

The Irish cereal harvest in 2017 came to 2.4 million tonnes. Approximately 2.1m tonnes of this is used for animal feed with the remainder used in the food and drinks sector. The volume of compound feeding-stuffs produced in 2017 increased by 8% to 4.9 million tonnes.

Approximately 60% are used for cattle, 14% for pigs, 13% for poultry and 13% for sheep and other animals. In Ireland, up to 90% of animal feed for ruminants is provided by grass, hay and silage. Other crops grown by farmers like kale, turnips and beans are not included.



Source: Dept. of Agriculture, Food and the Marine: Production of Compound Feedingstuffs, 2015-2017

The below table shows the calories contained in the animal fodder and feeds used in Ireland.

Crop	Annual Yield Tonnes/Yr	Land Area hectares	Food Energy KCal/kg	Energy Yield T Kcal per Yr	Persons fed per Year
Fodder – Grass	42,000,000	4,540,000	1,760	73.92	101,260,274
Winter Wheat	626,600	60,300	3,390	2.13	2,909,827
Winter Barley	913,700	65,000	3,540	2.10	4,430,819
Spring Barley	592,200	115,200	3,540	3.24	2,871,764
Imported Oil Seed	1,757,500*		4,400	8.80	10,593,151
Imported Grain	1,000,000*		3,400	6.80	4,657,534
* estimates	46,890,000	4,780,500			126,723,369

The so called efficient **Irish Farming system converts food calories sufficient to feed 127 million people to food that can only feed 21 million people**. It's worth pointing out that if we assume oil seeds yield 3 tonnes per ha and grain yield of 6 tonnes per ha (based on an assumption of lower yields in other countries) this implies that Irish meat production is also consuming the production from an additional 0.755 Mha in other countries. These imported feeds would have sufficient calories to feed 15 million people for a year in those countries.

Comparing the Inefficiency of Meat Production to Irish Food Waste

According to the EPA Ireland wastes 1.3 million tonnes of food each year. But our current meat and dairy based system converts 47 million tonnes of feed and fodder to approx. 2 million tonnes of meat, dairy and eggs. This is 34 times more than the total quantity of Irish food waste. A similar situation can be observed at the global level. Globally it's estimated that a third of food is wasted or 1.3 billion tonnes. But according to the IPCC AR5 Report the global meat and dairy food system converts 8.2 billion tonnes of feed and fodder to to 0.46 billion tonnes of animal products. This is six times the current estimate for global food waste.

7.3 Potential Number of People Fed on a Plant Based Diet in Ireland?

Currently 4.1 Mha is devoted to pasture, hay and grass silage and 0.44 Mha to rough grazing and cereals and fruit & horticulture production (0.35 Mha). Here we estimate the number of people that can be fed on plant based foods produced on 4 Mha using the average 2017 yields.

Crop	Annual Yield Tonnes/Yr	Land Area hectares	Food Energy KCal/kg	Energy Yield T Kcal per Yr	Persons fed per Year
Peas and Beans	9,900,000	1,500,000	3,470	34.35	47,058,904
Grains	10,080,000	1,200,000	3,390	34.17	46,809,863
Oil seeds	2,050,000	500,000	8,500	17.43	23,869,863
Potatoes	35,920,000	800,000	770	27.66	37,888,219
		4,000,000			155,626,849

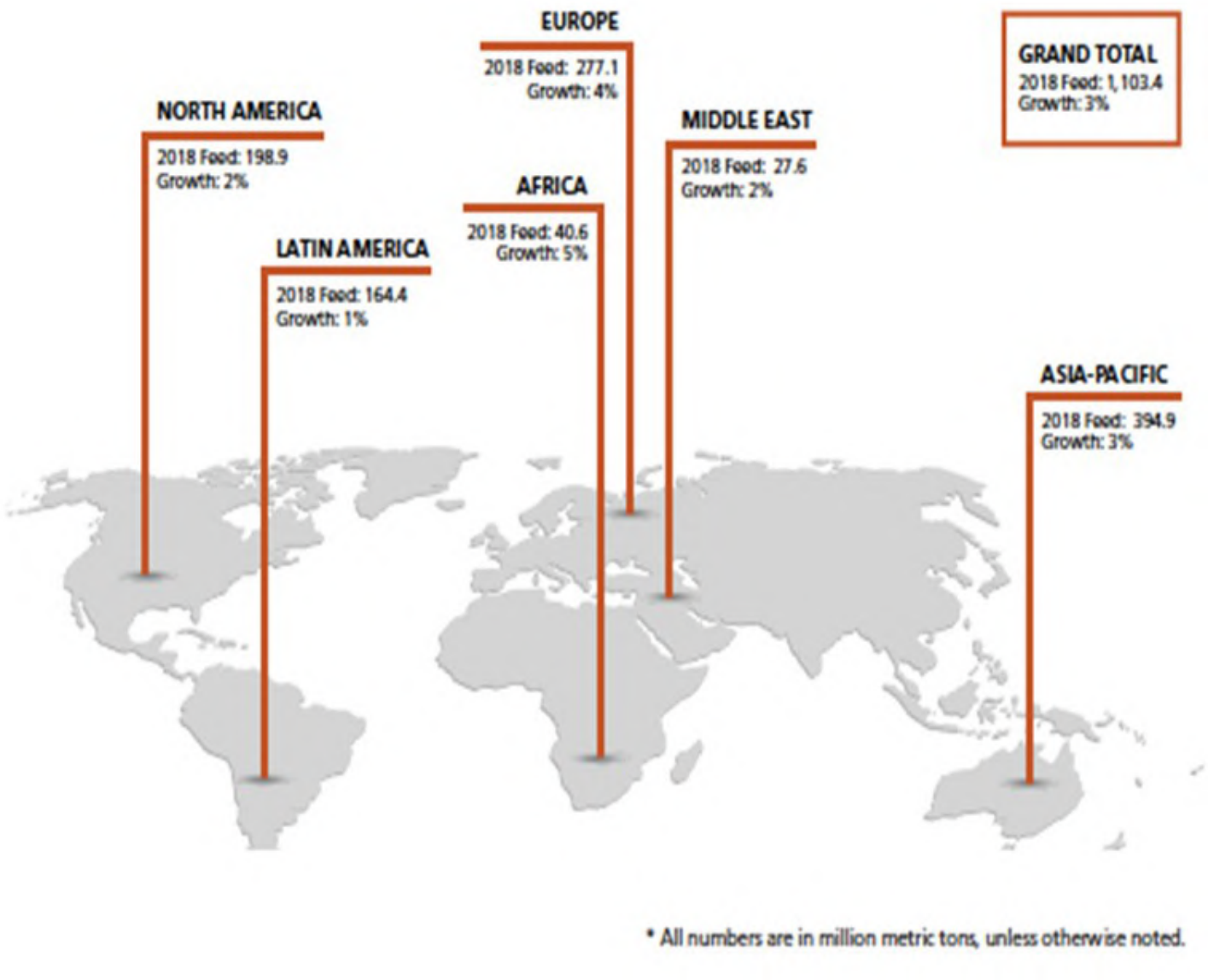
So on 4 Mha we could produce enough food calories to feed 155 million people instead of producing food for only 23 million people. In the previous section we assumed that total agricultural land use would be reduced from 4.5 Mha to 1.7 Mha, a reduction of 2.8 Mha. Using the average yields per hectare in Ireland in 2017 we show below that 1.7 Mha would produce enough food calories to feed approx. 70 million people.

Crop	Annual Yield Tonnes/Yr	Land Area hectares	Food Energy KCal/kg	Energy Yield T Kcal per Yr	Persons fed per Year
Peas and Beans	3,300,000	500,000	3,470	11.45	15,686,301
Grains	3,360,000	400,000	3,390	11.39	15,603,288
Oil seeds	1,230,000	300,000	8,500	10.46	14,321,918
Potatoes	22,450,000	500,000	770	17.29	23,680,137
		1,700,000			69,291,644

A VAS feeds three times the number of people currently being fed with meat and dairy products while leaving enough land for biodiversity and climate change mitigation and other vital ecosystem services. Many dairy farmers already grow kale, beans and maize to feed their cattle and so the skills for horticulture are there. But now these foods would be eaten directly by people or used to produce meat substitutes. Substantial further investment would still be needed to ensure a fair transition to a VAS.

7.4 How Animal Agriculture is driving Food Insecurity

Animal agriculture is an incredibly inefficient way to produce food. Globally it occupies 83% of farmland but provides just 18% of the calories consumed. Globally Beef Production occupies 60% of the land while producing only 2% of the food calories consumed. Animal agriculture causes hunger for two reasons: It occupies land that could be used to produce plant foods for people, and it directly competes with people for food calories. The below map shows that **1,103.4 million tonnes of animal feed were produced globally in 2018.**



Alltech Global Feed Survey 2018

But farm animals also consume a range of other foods as listed below.

- 1,103.4 million tonnes of animal feed;
- 2,300 million tons of grass and alfalfa;
- 1,100 Mt of other crops (legumes, turnips, etc.) and stovers;
- The IPCC AR5 global land use block diagram estimate that all pasturelands and grasslands currently provide a further 3,700 Mt/yr of dry matter biomass.

Animal agriculture converts 8,203 million tonnes of feed to just 310 million tonnes of meat (2016), 789 million tonnes of milk (2014) (which has about 80 million tons of solids) and 70 million tonnes of eggs (2014). 8.2 billion tonnes globally is converted to 0.46 billion tonnes of animal products. If we just consider the calories in the compound feeds and assume they have the same calories as maize (3,700 kcal/kg), this 1,103.4 million tonnes is enough calories for 5.6 billion people.

*"The world's **croplands (excluding pastures)** could feed 4 billion more people than they do now just by shifting from producing animal feed and biofuels to producing exclusively food for human consumption" – Institute on the Environment at the University of Minnesota 2013.*

In comparison to the **1,103.4 million tonnes of animal feed produced globally**, let's look at the UN World Food Programme (WFP). **The organisation assists "91.4 million people** in around **83 countries each year**, and is the leading humanitarian organisation saving lives and changing lives". **Every year**, they distribute more than **15 billion rations**. But each year the WFP **purchases just 3 million metric tons of food for all its programmes globally**. African countries alone produce 40.6 million tonnes of grain, legumes and oil seeds and feed it to animals wasting over 80% of the food calories.

Irish meat production imports 2.7 Mtonnes of feeds, requiring an additional 0.755 Mha in other countries. Approximately 55% is sourced from countries outside the EU, mainly Argentina, the USA, Ukraine, Canada and Brazil. These imported feeds have sufficient calories to feed 15 million people for a year in those countries.

Land cleared in the Amazon is used for growing soya and for beef farming often in areas occupied by indigenous people and small farmers whose legal rights are regularly infringed upon by large scale inefficient and destructive soy and beef operations. 90% of the soya grown worldwide is used for animal feed. Human rights will continue to be violated as people are pushed off their land to make way for large scale soy and beef operations.

"The Industrial Food Chain uses at least **75%** of the world's agricultural resources but provides food to less than **30% of the world's people."**

– Who will feed us?, 2017 ETC Group and GRAIN

"Without meat and dairy consumption, global farm land use **could be reduced by more than 75%** – an area equivalent to the US, China, EU and Australia combined – **and still feed the world**." – Reducing food's environmental impacts through producers and consumers: J. Poore, T. Nemecek, June, 2018.

World hunger is not a straightforward issue and has its roots in the control and allocation of resources rather than availability of resources. Yet it's undeniable that animal agriculture contributes hugely to the scarcity and high price of staple crops while actively wasting food due to the reality of trophic level inefficiencies. A global vegan shift would not automatically end world hunger. However, for those of us privileged to be living in a society of abundance each individual's shift to veganism is a great place to start.

We have seen how a VAS would increase food calories by 300% on just 1.7 Mha. This would enable Irish farmers to significantly contribute to food security and famine relief in other countries with a sufficient food surplus to feed over 60 million people for a year as well as no longer importing enough calories to feed 15 million people for animal feeds.

Chapter 8:
Climate Change and Irish Agriculture

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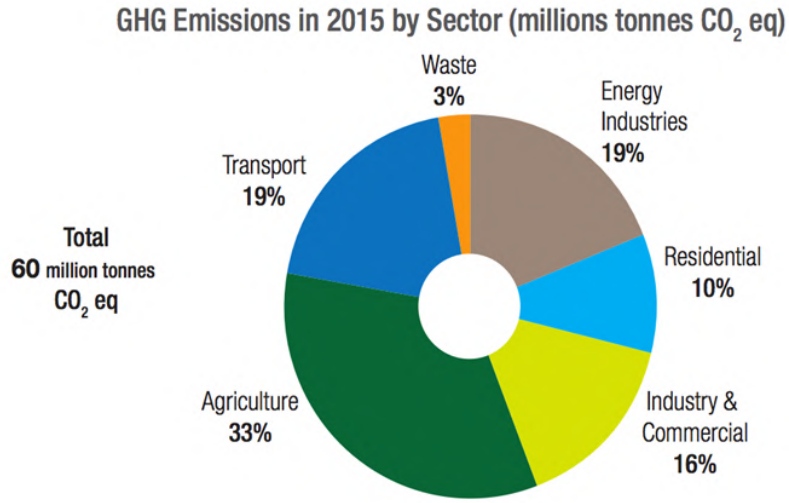
Food production is one of the largest contributors to climate change. Agriculture directly contributes about 15–23% of all GHG emissions, which is comparable to transportation. But when land conversion and the wider downstream food system processes, including food waste, are taken into account, the total contribution of food to emissions can be as high as 29%. Livestock alone account for 12–19% of all GHG emissions.

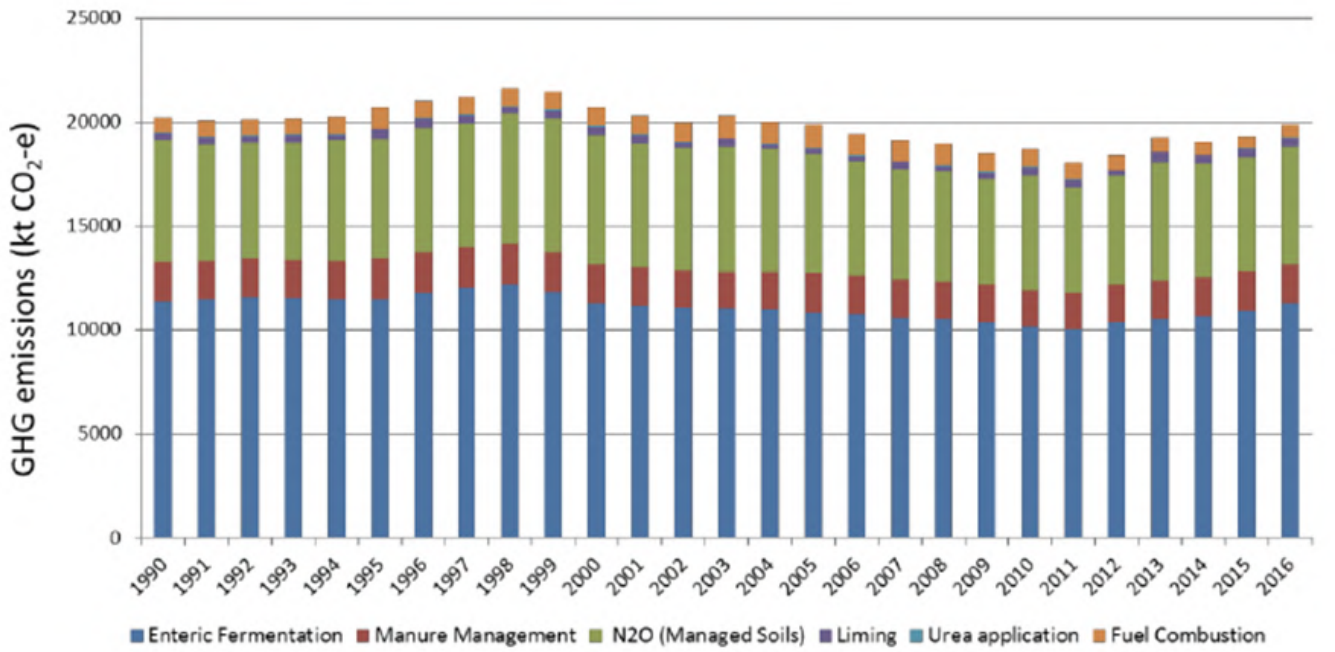
According to Greenpeace: "Animal agriculture accounted for 12 - 17% of the EU's GHG emissions in 2013. Of these, 27% were methane and 23% were nitrous oxide. Recent studies show that halving the EU's consumption of meat, dairy and eggs could cut EU agricultural GHG emissions by 25 - 40%. Globally, going a step further and adopting a vegetarian or vegan diet would cut agricultural GHG emissions by 63% and 70%, respectively".

The UN's Intergovernmental Panel on Climate Change concluded that "the potential to reduce GHG emissions through changes in consumption was found to be substantially higher than that of technical mitigation measures [such as improved cropland or livestock management]".

In Ireland Agriculture is **the leading cause** of climate change as shown in the below diagram. Because only 1.5% of agricultural land is used to produce crops for human consumption, meat and dairy production are responsible for 32.67% of Ireland's GHG emissions as shown below.



Agriculture is responsible for 20 Million tonnes (Mt) CO_2 eq.

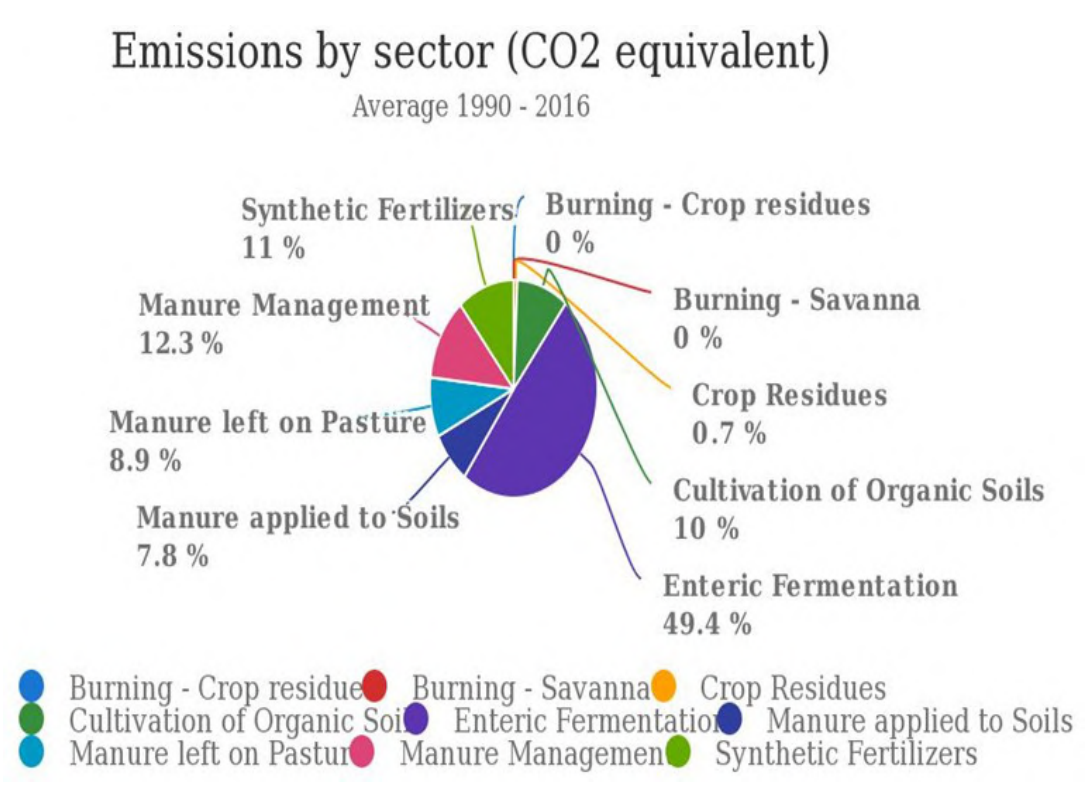


"Agricultural emissions are dominated by methane (CH_4), which makes up 64% of agricultural emissions, 80% of which is attributable to cattle and sheep enteric fermentation, with the remainder attributable to manure management in liquid manure systems. Nitrous oxide (N_2O) from fertiliser, manure and animal excreta directly onto pasture constitutes the vast bulk of the remaining emissions (30.7%), with minor CO_2 emission sources associated with liming and urea application to land and fuel combustion."

Sessile oak–woodrush woodland, Derrycrag Nature Reserve, Co. Galway, Dept of Agriculture.

The below FAO diagram shows a breakdown of these agricultural emissions. This shows that manure management produced 5.8 Mt and enteric fermentation produced 9.88 Mt. Cultivation of organic soils generated 2 Mt. This would include growing crops and also the planting of grass pastures. Fertilisers are applied to grass and crops and generated 2.2 Mt. Assuming that emissions from cultivation of soils and fertilisers are across all agricultural land, then animal agriculture is responsible for 98.5% of these emissions or 4.14 Mt. Crop residues produced just 0.14 Mt.

Emissions from meat and dairy production produces 15.68 + 4.14 = 19.82 Mt or 99% of Ireland's agricultural emissions.



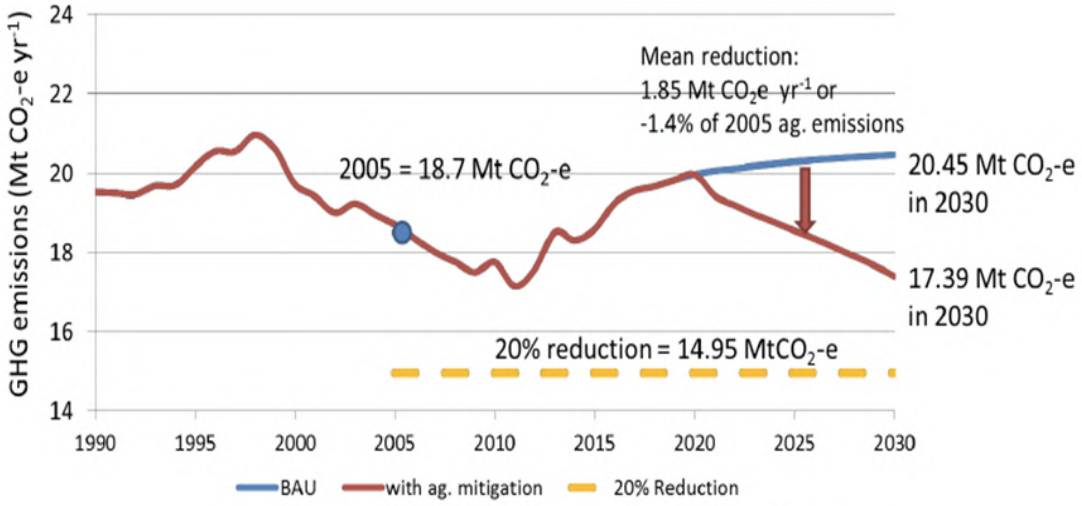
Source: FAOSTAT (Jan. 16, 2019)

It's important to note that this does not include the emissions from agricultural fossil fuels or any of the food sector fossil fuel emissions beyond the farm gate. In 2017 an OECD Joint Working Party on Agriculture and the Environment produced a report on Improving Energy Efficiency in The Agro-Food Chain. This stated: "FAO's (2011) indicative estimates on energy consumed by the agri-food sector and its components show that "globally, the agri-food sector accounts, directly and indirectly, for around **30% of the world's total end-use energy consumption** – with more than 70% consumed **beyond the farm gate**." For Ireland this would be an additional 12 Mt of GHG emissions. This includes energy for refrigeration, transport, packaging, processing, retail, and cooking. This also does not include the GHG emissions from Food Waste. Globally a third of all food produced is wasted. Ireland also produces about 0.5 Mtonnes of animal based product from slaughterhouses which is currently (2017) not even counted as food waste.

According to the Teagasc Report 'An Analysis of the Abatement Potential of GHG Emissions from Irish Agriculture, 2021-2030': "This study quantified the impact of mitigation on GHG emissions from Ireland. As such, it complied with IPCC rules and accounted for emissions arising within national boundaries. However, up-stream emissions in terms of feed and fertiliser manufacture and downstream emissions (transport, refrigeration) in intensive livestock production (dairy, beef, pig meat) can account for 32%-24% of total livestock emissions, with approximately 40% arising from energy emissions and 60% from land-use emissions (Weiss & Leip 2012)".

"Similarly, under IPCC rules, the GHG and land-use impacts associated with soya production are not included in the GHG emission of Irish agriculture, although emissions from soya meal production are circa. 800 $kgCO_2$-e per tonne meal" (Sonesson et al. 2009).

The below Teagasc Diagram shows Ireland's Agricultural GHG emissions from 1990 and projected to 2030, without mitigation (Blue) and with mitigation (Red).



The orange line represents a *pro-rata* 20% reduction in sectoral emissions.

An Analysis of the Abatement Potential of GHG Emissions from Irish Agriculture, 2021-2030, Teagasc 2018

According to the Teagasc Report, "Mitigation from land-use/land-use change and forestry (LULUCF) and energy will deliver further reductions to non-ETS (Emissions Trading System) and/or total national emissions across the commitment period. The mean reduction from LULUCF is capped at 26.8 million tonnes CO_2-e for 2021- 2030 or a mean annualised reduction of 2.68 Mt CO_2-e and along with agricultural mitigation can deliver a 9.6% reduction on 2005 emissions. Further mitigation from energy/bioenergy will deliver 1.37 Mt CO_2-e to either non-ETS or ETS, depending on where the energy displacement occurs (eg. electricity generation or residential heating)." Without mitigation, Irish GHG (and ammonia) emissions are likely to increase mainly due to increased dairy production. With all of these mitigation measures emissions from agriculture will be reduced by only 15%.

The IPCC Special Report on Global Warming of 1.5°C (SR1.5) released in October 2018 shows that to keep the global mean temperature rise below 1.5°C requires global GHG emissions reductions from 2010 levels of 45% by 2030 and to be net-zero (full decarbonisation) by 2050. Ireland is legally bound by the Paris Climate Agreement to "a 40% reduction in EU-wide emissions by 2030 compared to 1990. The specific details of the contribution to this 40% to be made by each Member State in respect of the non-ETS sector (i.e. including agriculture) was the subject of a European Commission proposal published on 20 July 2016."
The Ireland 2019 Cross Party Report on Climate Change has stated that: "For Ireland, it means Ireland's emissions should be about 33 million tonnes of carbon dioxide equivalent in 2030 compared to 60 million tonnes in 2017 – a 45% reduction." If we stay with an animal agriculture system we will need to reduce GHG emissions from Energy, Transport, Industry, Heating, Domestic from 40 Mt to 16 Mt in the next ten years. It's clear that without a major rapid transformation of the agricultural system we will not meet our climate goals.

8.1 Emissions Reductions of a VAS

Transitioning to a VAS would eliminate the emissions from enteric fermentation and manure management, eliminating 78.4% of emissions or 15.68 Mtonnes. We are assuming that total agricultural land use will be reduced from 4.5 Mha to 1.7 Mha, a reduction of 62%. There would be a large increase in nitrogen fixing legumes, which could potentially reduce the need for fertiliser use. For these reasons I am going to assume a reduction in emissions from fertiliser use and organic soil cultivation of 50% from 4.2 to 2.1 million tonnes. There is likely to be an increase in emissions from crop residues. In 2017 0.3 Mha were planted with crops. This would increase to 1.7 Mha, potentially generating an additional 0.65 Mtonnes. Overall agricultural emissions would reduce by (17.8-0.65)= 17.15 Mtonnes. **Ireland's Overall Emissions would drop to 43 MTonnes per Year.**

8.2 Carbon Sequestration Potential of a VAS

Sequestration Potential of Forests
The EPA Report 'GHG Fluxes from Terrestrial Ecosystems in Ireland' states the following: "It is estimated that the average rate of carbon sequestration by Irish forests is approximately 3.36 t C ha^{-1} yr^{-1} (Kilbride et al. 1999), based on the model developed by Dewar and Cannell (1992). More recent work by Byrne (2010) and Black et al. (2009) reported that first-rotation Sitka spruce stands are a carbon sink at 10 years and that this reaches a maximum of 9 t C/ha/yr before the time of first thinning, declining to 2 t C/ha/yr in older stands. The rate of carbon sequestration is similar to that found in Sitka spruce stands in the UK from 7 t C/ha/yr at canopy closure to 3t C/ha/yr in older forestry stands (Byrne, 2010). It has been noted that the total carbon reservoir or store in Irish forestry exceeds 1 billion tonnes of CO_2, most of which is in the soil, and that the annual removal of CO_2 from the atmosphere by Ireland's forests exceeds 6 million tonnes of CO_2."

This report also states that "the forest ecosystem may also emit carbon if its soils are organic or organo-mineral. Based on county-specific data, it is assumed that forests on mineral soils in Ireland do not lose CO_2 back to the atmosphere (Duffy et al., 2014)." So the areas where broad leaf native forests are planted must take into consideration the soil and plant only on mineral soils to ensure the forest is a net carbon sink. For areas of land which have peat soils these should be restored to wetlands and bog or native grasslands which can also act as a carbon sink. The article Carbon Sequestration in Irish Forests by Coford contains the following table.

Average rate of C sequestration in forest plantations during a single rotation (after Dewar and Cannell 1992).

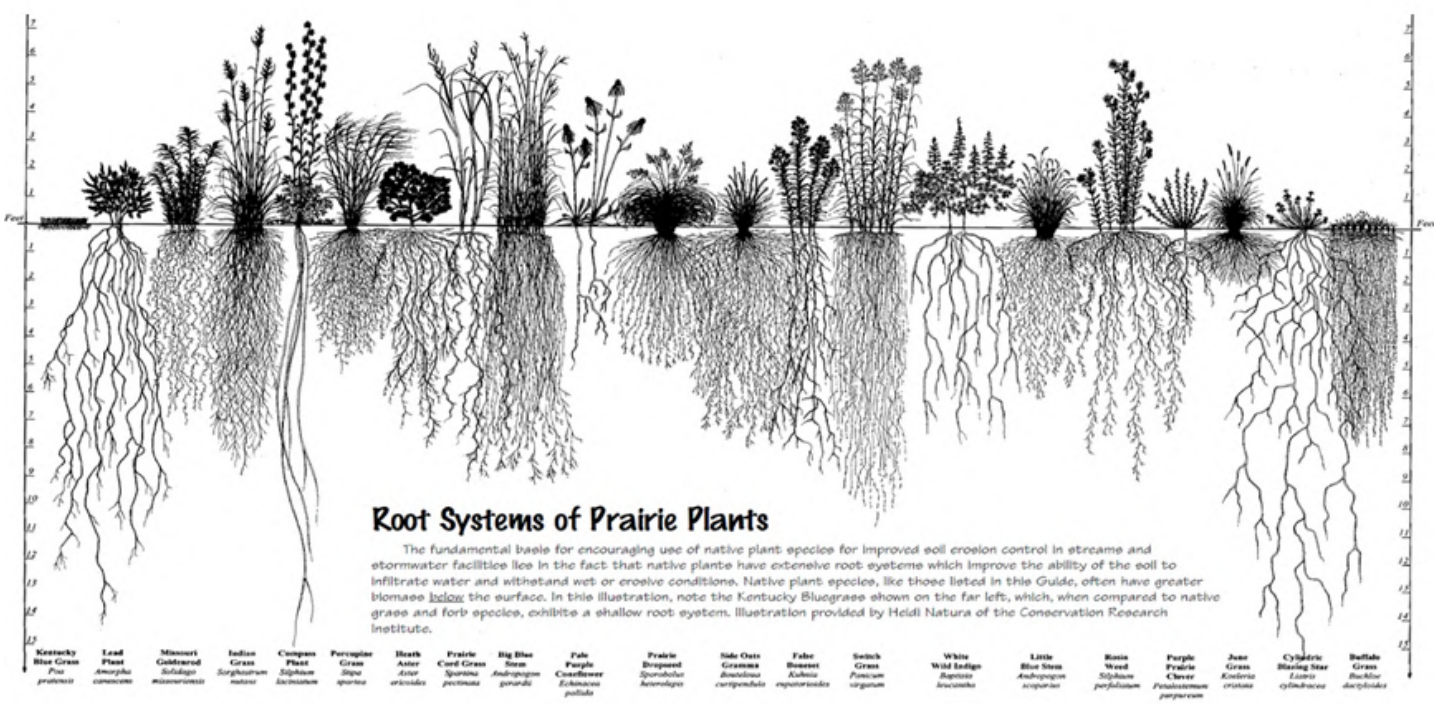
	Yield Class	C Sequestration Rate (t C/ha/yr)
Sitka spruce	24	4.4
	22	4.3
	20	4.1
	18	3.8
	16	3.6
Beech	6	2.4
Oak	4	1.8

If Native woodlands sequester an average of 2.1 t Carbon ha^{-1} yr^{-1} this is equivalent to 7.7 t CO_2 ha^{-1} yr^{-1}. If we convert 1.7 Mha of land to native broadleaf forests to reach 2.5 Mha of forest cover, 1.7 M ha sequesters 13.1 Mt of CO_2 yr^{-1}.

1995 saw the highest level of afforestation (23,710 hectares) ever achieved in the country in a single year. If 25,000 ha were planted each year then it would take 44 years to reforest 1.1 Mha. However, as shown in the Ecological Restoration Case Study, just by gradually removing the grazing animals from the land and allowing it to naturally regrow, landowners and local communities will be able to create the conditions for biodiversity to thrive once again.

Sequestration Potential of Grasslands

The below diagram shows the extensive roots of native plants. This is particularly the case for grasslands like the Cerrado and the US Prairies. The roots of Kentucky Rye Grass, a typical monoculture grass, is shown on the far left.



At times, Native Grasslands can sequester as much as a forest. The EPA 2018 report 'GHG Fluxes from Terrestrial Ecosystems in Ireland' states: "Relative to other ecosystems, this blanket bog has a Net Ecosystem Exchange (NEE) of approximately –0.5 t C-CO_2 ha $^{-1}$ yr^{-1} in comparison with a NEE in Irish grasslands of –3 t C-CO_2 ha^{-1} yr^{-1} and a NEE in Irish forestry of –10 t C-CO_2 ha^{-1} yr^{-1}.

In our proposal we have assumed that a further 1.1 Mha would be converted to native grasslands, meadows, and bog and wetlands. We assume that this would result in an average of 0.5 to 3 t of CO_2/ha/yr. This would sequester 1.9 Mt of CO_2/yr on 1.1 Mha. Total Sequestered by converting 2.8 Mha to forest and native grasslands and wetlands is estimated to be about 15 Mt of CO_2 /yr. **Ireland's Total Emissions would drop to 28 Mt per Year – a reduction of 53%.** This transition is certainly possible by 2030.

We assume that the emissions from the post farm gate would remain the same. However, it's likely that there would be significant savings for example by the elimination of energy intensive processes like pasteurisation, refrigeration and the evaporation needed to produce milk powder and the processing of the huge volume of wastes generated by the meat and dairy industries.

Alder–meadowsweet alluvial woodland on poorly draining gley soil. Hazelwood, Co. Sligo

Sequestration Potential of Soil

"According to Rattan Lal, director of Ohio State University's Carbon Management and Sequestration Center, the world's cultivated soils have lost between 50 and 70 percent of their original carbon stock, much of which has oxidized upon exposure to air to become CO_2. In grasslands up to 75% (depending on the species) of the total plant biomass is below the soil surface. There are an estimated 2,500 Gt of carbon in soil, compared with 800 Gt in the atmosphere and 560 Gt in plant and animal life." According to the Global Land Outlook Report: "A third of the planet's land is severely degraded and fertile soil is being lost at the rate of **24bn tonnes** a year". It is essential that as Ireland transitions to a VAS they transition to what are being called Regenerative or Agro-ecological approaches that minimise ploughing and understand the soil nutrient cycles and how to create a healthy soil micro-biome.

We have not included an estimate of soil carbon sequestration.

8.3 Global Climate Mitigation Potential of a VAS

In December 2015, Sailesh K. Rao, Atul K. Jain and Shijie Shu published a peer reviewed paper titled 'Assessment of the Carbon Sequestration Potential of Grasslands and Pasturelands Reverted to Native Forests', GC13E: Livestock, Land Use and the Environment, AGU Fall Meeting, 14-18.

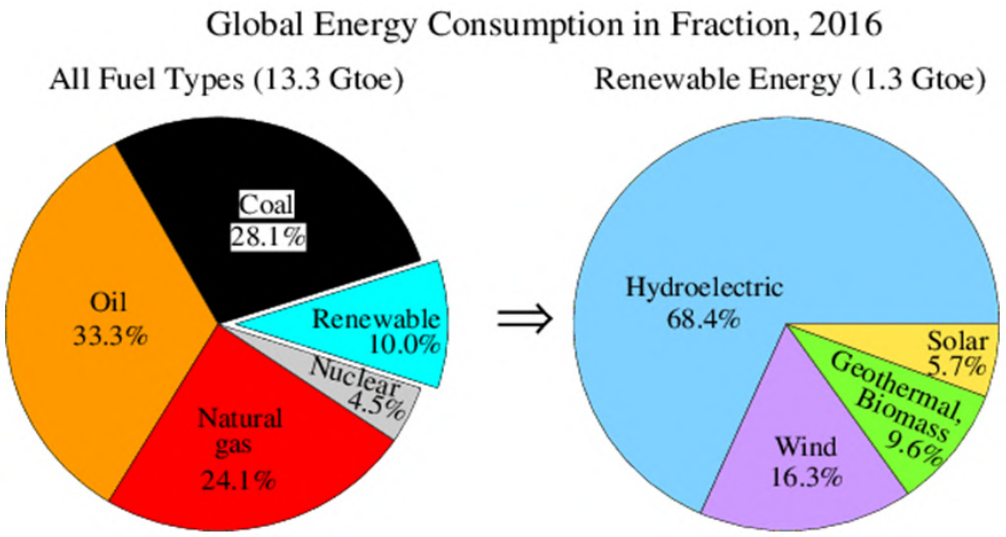
This paper calculated the carbon sequestration potential of grasslands and pasturelands that can be reverted to native forests as 265 GtC (on 19.6 MKm^2 of land area), just 41% of the total area of such agricultural lands. Since this carbon sequestration potential is greater than the 240 GtC that has been added to the atmosphere since the industrial era began, it shows that such global lifestyle transitions have tremendous potential to **fully reverse climate change**.

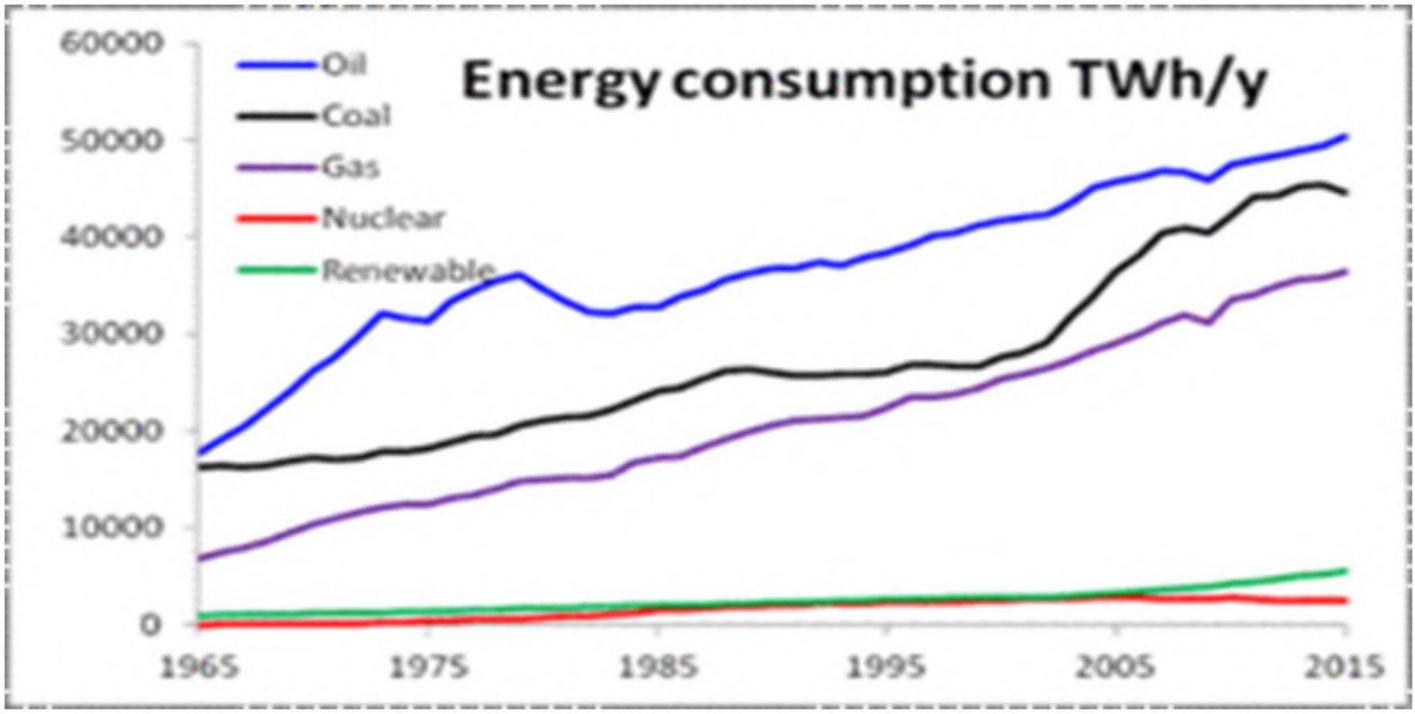
Despite the enormous potential of veganism, the main solution still being promoted by both governments and environmental organisations is to transition from fossil fuels to a low carbon energy system. This is certainly necessary, but prime importance needs to be given to the changes in the agricultural system. Although there is a lot of news about the growth in the renewable energy market it is still just 3% of global energy consumption (as shown below) though it can account for up to 50% of new energy investments in some countries.

'The World Energy Investment Outlook' – a 2018 study from the International Energy Agency – is a full and comprehensive update of the energy investment picture to 2035 – the first full update since 2003. It states that: "$53 trillion in cumulative investment in energy supply and in energy efficiency is required to 2035 to get the world onto a 2°C emissions path. Investment of $14 trillion in efficiency helps to lower energy consumption by almost 15% in 2035." Currently Global energy use is continuing to increase as can be seen in the below diagram which just shows a contraction in the use of coal but all other energy sources are still increasing. Meat and Dairy consumption are also increasing globally, though some countries like the US are seeing a reduction in the consumption of red meat.

Total Area of Grasslands/Pasture lands at present:	47.3 MKm^2
Carbon sequestration in such lands at present:	52.8 GtC
Total Area of such lands reverted to forest biomes:	19.6 MKm^2
Carbon sequestration in reverted lands at present:	27.5 GtC
Carbon sequestration in reverted forest biomes at maturity:	292.7 GtC
Net carbon sequestration at forest maturity:	265.2 GtC
Net carbon sequestration at forest maturity per unit area:	13.6 KgC/m^2
Estimated above ground re-growth over 20 years (Silver et al[1]):	617 $gC/m^2/yr$ * 20 yrs = 12.3 KgC/m^2

[1]Silver, W.L., Ostertag, R., and Lugo, A. E., "The Potential for Carbon Sequestration through Reforestation of Abandoned Tropical Agricultural and Pasture Lands, Restoration Ecology, Vol 8, Issue 4, Pages 394-407,Dec. 2000.





The need to reverse climate change is urgent and the lowest cost change available nationally and globally is a transition to a VAS. The next section outlines the estimated costs to begin the transition of the Irish Electricity, Heating and Transport sectors (excluding agriculture).

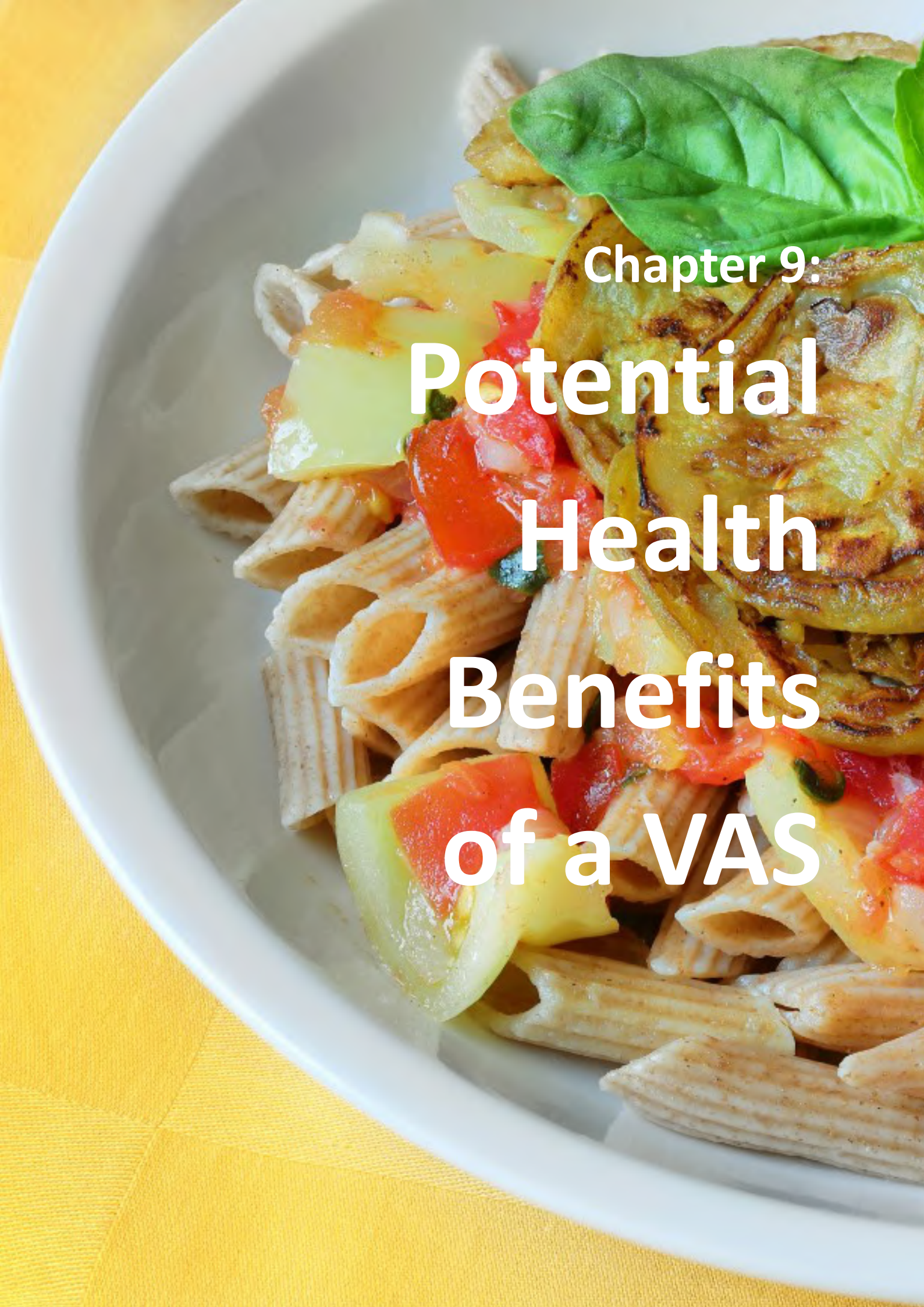
8.4 The Cost of Climate Change Mitigation in Ireland

A recent report from the Irish Academy of Engineering, entitled *Ireland's 2030 Greenhouse Gas Emissions Target: An Assessment of Feasibility and Costs*, has been produced based on its assessment of the technical feasibility and costs of achieving a 40% reduction in greenhouse gas emissions compared to 1990 by 2030.

The report comments that: "Achieving the 2030 targets will be enormously costly for Ireland – requiring a capital expenditure of around €35 billion up to 2030. There would be savings on fossil fuel imports, but these are modest in comparison. It must be emphasised that the overarching priority must be to prudently reduce national energy demand and promote energy conservation/ efficiency measures while ensuring continued economic growth." The Irish Academy of Engineering's analysis concludes that the non-ETS targets cannot be achieved without a significant reduction in GHG emissions from the agriculture sector. The Academy estimates that a reduction of 1.4 million tonnes in agriculture emissions, from 2014 levels, will be needed to achieve the 2030 target. This is in addition to the credits which will be available to Ireland from carbon sequestration through changes in land use and forestry.

The Irish Academy of Engineering's conclusion is that the 2030 targets are just about feasible but will require huge investment. They note that: "The measures identified in this report would require an investment of approximately €35 billion by 2030. The cost of reducing emissions in certain sectors has not been estimated, due to a lack of data and therefore the total cost is likely to be significantly more than €35 billion." The approach taken by the Academy is to maximise emission reduction in the Emission Trading Scheme (ETS) sector (energy sector) and minimise emission reduction requirements in the non-ETS sectors (agriculture, transport, domestic and commercial sectors), where GHG reduction opportunities are more difficult and generally more expensive to implement."

But our report shows that the most effective solution to climate change Globally and in Ireland is to be found in the non-ETS sector of agriculture. A transition to a VAS together with the restoration of land to native woodlands, grasslands, and wetlands would reduce **Ireland's Total Emissions to 28 MTonnes per Year – a reduction of 53%.** Another significant land use intervention is the ending of burning peat as a fuel and the large scale restoration of the peat bogs. Large scale investment in a deep retrofit of Ireland's buildings and in wind and solar energy generation could see Ireland transition to a Carbon neutral economy.



Chapter 9:

Potential Health Benefits of a VAS

Chapter 9: Potential Health Benefits of a VAS

This section explores the impact of a vegan diet on population health and health care costs and looks at some of the challenges to the large scale adoption of plant based diets.

Obesity, Undernutrition, and Climate Change
The 2019 Lancet Commission Report titled, 'The Global Syndemic of Obesity, Undernutrition, and Climate Change', begins with the following statement: "Malnutrition in all its forms, including obesity, undernutrition, and other dietary risks, is the leading cause of poor health globally. In the near future, the health effects of climate change will considerably compound these health challenges. Climate change can be considered a pandemic because of its sweeping effects on the health of humans and the natural systems we depend on (ie, planetary health). These three pandemics – obesity, undernutrition, and climate change – represent The Global Syndemic that affects most people in every country and region worldwide."

The Commission applied a systems perspective to understand and address the underlying drivers of The Global Syndemic within the context of achieving the broad global outcomes of human health and wellbeing, ecological health and wellbeing, social equity, and economic prosperity. The major systems driving The Global Syndemic are food and agriculture, transportation, urban design, and land use. An analysis of the dynamics of these systems sheds light on the answers to some fundamental questions. Why do these systems operate the way they do? Why do they need to change? Why are they so hard to change? What leverage points (or levers) are required to overcome policy inertia and address The Global Syndemic?

The Lancet Commission identified five sets of feedback loops as the dominant dynamics underlying the answers to these questions. They include:

- Governance feedback loops that determine how political power translates into the policies and economic incentives and disincentives for companies to operate within;
- Business feedback loops that determine the dynamics for creating profitable goods and services, including the externalities associated with damage to human health, the environment, and the planet;
- Supply and demand feedback loops showing the relationships that determine current consumption practices;
- Ecological feedback loops that show the unsustainable environmental damage that the food and transportation systems impose on natural ecosystems; and
- Human health feedback loops that show the positive and negative effects that these systems have on human health.

"The economic burden of The Global Syndemic is substantial and will have the greatest effect on the poorest of the 8.5 billion people who will inhabit the earth by 2030. The current costs of obesity are estimated at about $2 trillion annually from direct healthcare costs and lost economic productivity. These costs represent 2.8% of the world's gross domestic product (GDP) and are roughly the equivalent of the costs of smoking or armed violence and war. Economic losses attributable to undernutrition are equivalent to 11% of the GDP in Africa and Asia, or approximately $3.5 trillion annually. The World Bank estimates that an investment of $70 billion over 10 years is needed to achieve SDG targets related to undernutrition, and that achieving them would create an estimated $850 billion in economic return."

Malnutrition in all its forms refers to an abnormal physiological condition caused by inadequate, unbalanced, or excessive consumption of macronutrients or micronutrients. The report considers malnutrition in burden of disease terms as "the combined components of child and maternal malnutrition, high body-mass index (BMI), and dietary risks, representing a composite variable of dietary components associated with Non Communicable Diseases (NCDs), such as diets low in whole grains, fruit, vegetables, nuts and seeds and high in sodium, red meat, and sugar-sweetened beverages."

The EAT Lancet Commission 2019 Report outlines how "unhealthy diets are the leading cause of ill health worldwide, with 800 million people currently hungry, 2 billion malnourished and a further 2 billion people overweight or obese". The report analyzed the potential impacts of dietary change on diet-related disease mortality and concluded that dietary changes from current diets toward healthy diets are likely to result in major health benefits. This includes preventing approximately 11 million deaths per year, which represent between 19% to 24% of total deaths among adults.

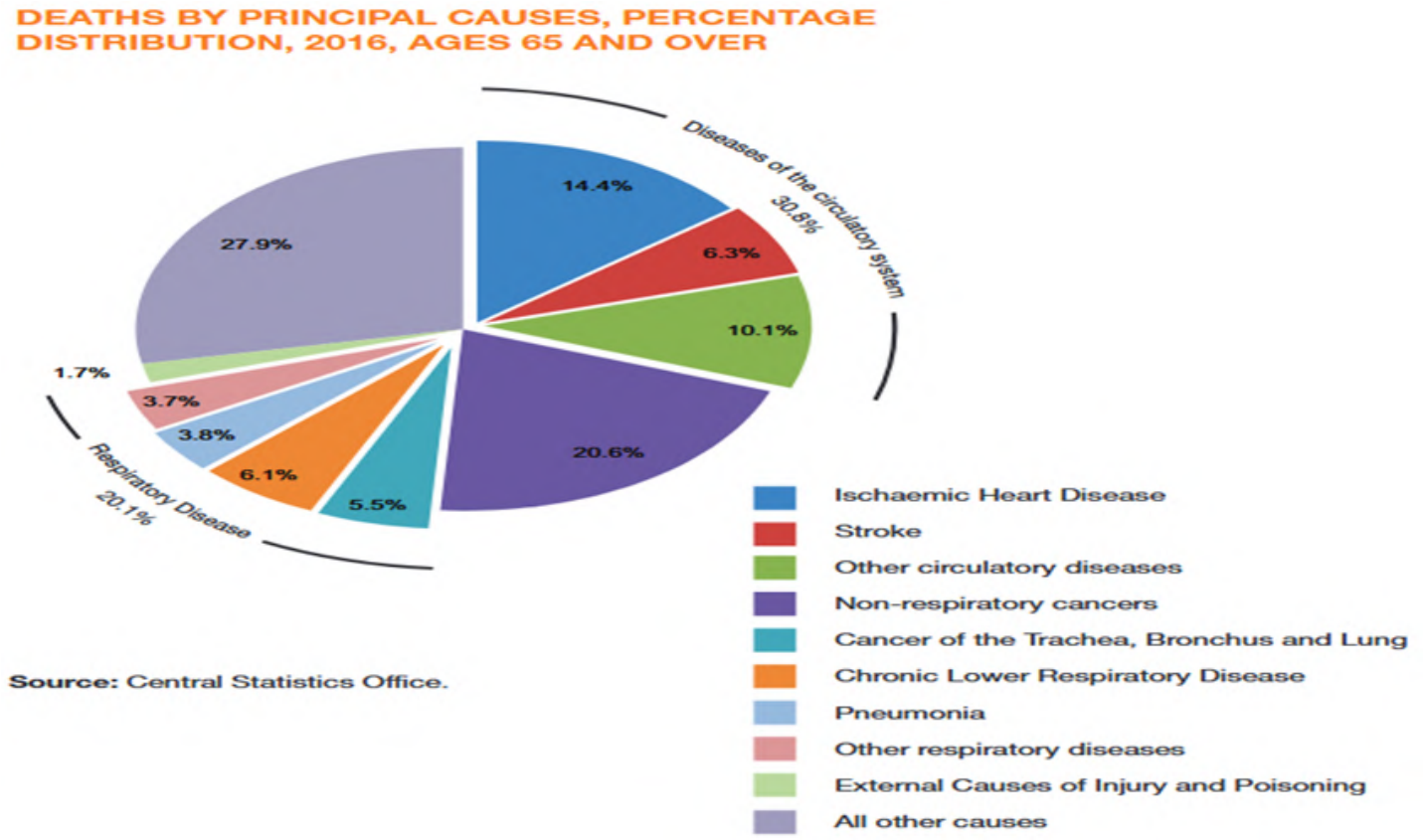
9.1 Health Benefits of a VAS

Today diet is the leading cause of death globally and in Ireland, and is the main cause of chronic conditions including cardiovascular disease, some cancers, diabetes, and obesity.

Diet plays a huge role in the development of these non-communicable diseases. In this section we present the findings of two recent studies and their recommendations. The first study outlined the health, environmental and economic benefits of a global transition to a vegan diet. The second study was an Irish study that looked at how many lives could potentially be saved by eating less meat and more fruits and vegetables.

Analysis and valuation of the health and climate change co-benefits of dietary change, Marco Springman, PNAS, 2015.
To evaluate the potential health and environmental benefits of dietary changes this study constructed four alternative diets: one reference scenario based on projections of diets in 2050; a scenario based on global dietary guidelines which includes minimum amounts of fruits and vegetables, and limits to the amount of red meat, sugar, and total calories; and two vegetarian scenarios, one including eggs and dairy (lacto-ovo vegetarian), and the other completely plant-based (vegan).

The research paper concluded that moving to diets with fewer animal-sourced foods and more fruits and vegetables would have major benefits. They estimated that adoption of global dietary guidelines would result in 5.1 million avoided deaths per year. Adoption of a vegetarian diet would save 7.3 million lives and global veganism would save 8.1 million lives. This represents a 6-10% reduction in global mortality.



Business as usual resulted in GHG emissions associated with food consumption increasing by 51% by 2050. Food-related GHG emissions in the dietary guidelines scenario were 29% less than reference emissions in 2050, and 7% greater than emissions in 2005/2007. The vegetarian diets resulted in food-related GHG emissions by 2050 that were 45–55% lower than the 2005/2007 levels and the vegan diet resulted in emissions that were 63–70% lower than the reference. In a statement the author Marco Springman noted that the report estimates that "these dietary changes would have a value to society of more than US$1 trillion – even as much as US$30 trillion. That's up to a tenth of the likely global GDP in 2050."

Modelling the impact of specific food policy options on coronary heart disease and stroke deaths in Ireland, British Medical Journal Open, July, 2013.
"The research examined two different diet change scenarios to improve cardiovascular health given that "a total of 4,080 cardiovascular deaths (2,966 Coronory Heart Disease (CHD) deaths; 1,114 Strokes) were reported in the age group of 25–85 years in 2010 in Ireland".

First: reductions in dietary salt by 1g/day, trans fat by 0.5% of energy intake, saturated fat by 1% energy intake and increasing Fruit/Veg (F/V) intake by 1 portion/day.

The small, conservative changes in food policy could result in approximately **395 fewer cardiovascular deaths per year**; approximately 190 fewer CHD deaths in men, 50 fewer CHD deaths in women, 95 fewer stroke deaths in men, and 60 fewer stroke deaths in women. Approximately 28%, 22%, 23% and 26% of the 395 fewer deaths could be attributable to decreased consumptions in trans fat, saturated fat, dietary salt and to increased Fruit/Veg consumption, respectively. The 395 fewer deaths represent an overall 10% reduction in CVD mortality."

"Second, a more substantial but politically feasible scenario: reductions in dietary salt by 3g/day, trans fat by 1% of energy intake, saturated fat by 3% of energy intake and increasing Fruit/Veg intake by 3 portions/day. Modelling the more substantial but feasible food policy options, we estimated that CVD mortality could be reduced by up to **1,070 deaths/year**, representing an overall 26% decline in Cardio Vascular Disease mortality."

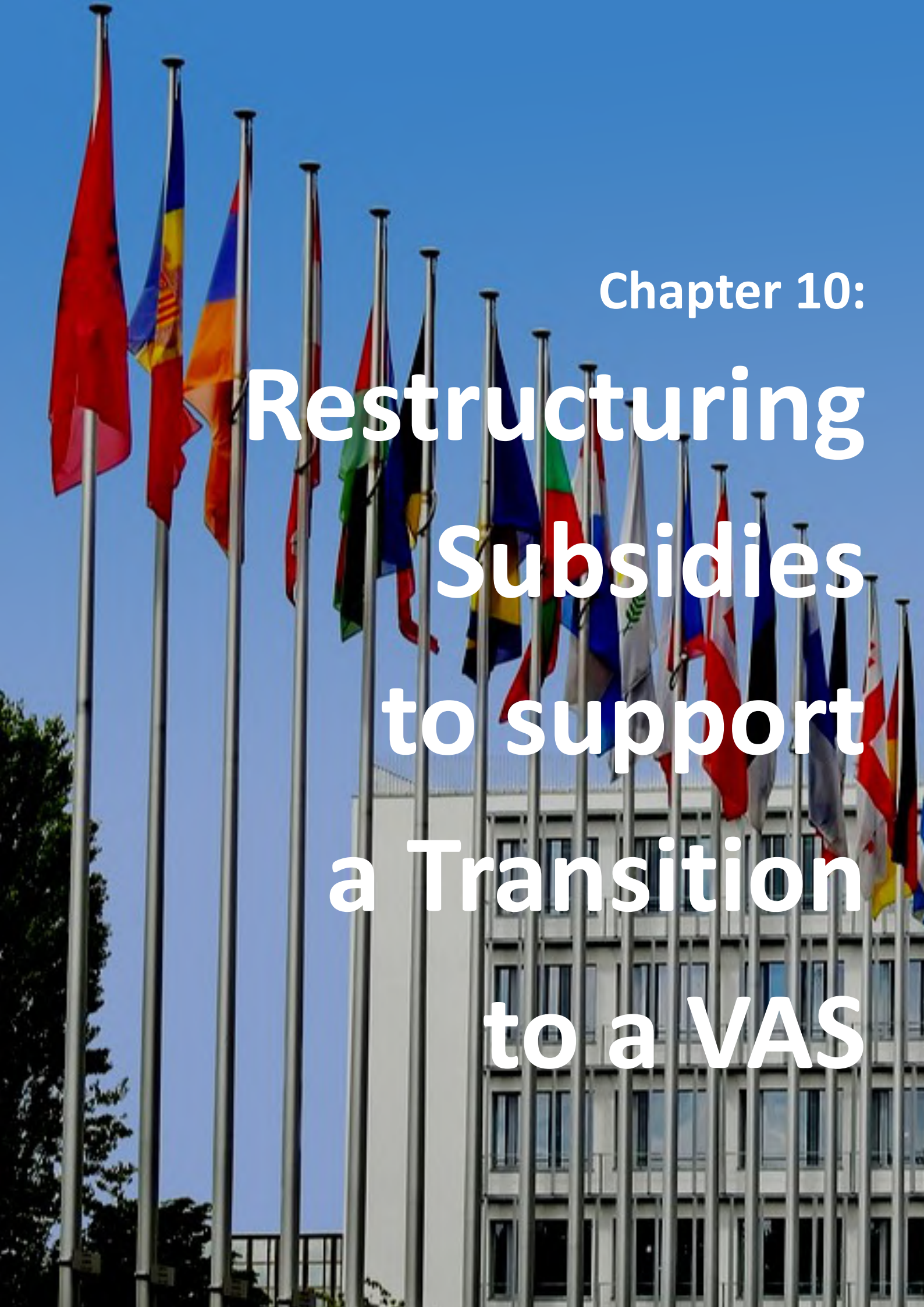
9.2 National Dietary Guidelines

Dietetic Associations around the world agree that a vegan diet is nutritionally complete. The Academy of Nutrition and Dietetics, Australia's National Health and Medical Research Council, the Portuguese National Programme for the Promotion of a Healthy Diet, the British Nutrition Foundation, and the Canadian Pediatric Society all agree that "a well-planned vegan diet, including dietary supplements, can cover the nutrient requirements in children and adolescents, if adequate energy intake is ensured." For example, the American Dietetic Association says: "Appropriately planned vegan diets are healthful, nutritionally adequate, and may provide health benefits in the prevention and treatment of certain diseases. They are appropriate for individuals during all stages of the life cycle, including pregnancy, lactation, infancy, childhood, and adolescence, and for athletes." The UK NHS also agree that a vegan diet is nutritionally adequate.

According to the 2019 Lancet Comission Report, 'The Global Syndemic of Obesity, Undernutrition, and Climate Change': "National dietary guidelines serve as a basis for the development of food and nutrition policies and public education to reduce obesity and undernutrition and could be extended to include sustainability by moving populations towards consuming largely plant-based diets. However, many countries' efforts to include environmental sustainability principles within their dietary guidelines failed due to pressure from strong food industry lobbies, especially the beef,

dairy, sugar, and ultra-processed food and beverage industry sectors. Only a few countries (ie, Sweden, Germany, Qatar, and Brazil) have developed dietary guidelines that promote environmentally sustainable diets and eating patterns that ensure food security, improve diet quality, human health and wellbeing, social equity, and respond to climate change challenges". When Canada recently completed their dietary recommendations they removed dairy as a necessary part of a healthy diet and included legumes, nuts and seeds as necessary part of a sustainable and healthy diet. The EAT-Lancet Commission Report on Food calls for a transition to plant based proteins and fats and makes protein from meats optional.

In Ireland the food pyramid that guides all government recommendations and education on what foods need to be consumed is produced by the Department of Health. It's essential that the government reflect the WHO Guidelines and incorporate sustainability into its recommendations as the EAT Lancet Commission does. The committee needs to be completely independent and unbiased in order to make recommendations that deliver human and environmental health.



Chapter 10:

Restructuring Subsidies to support a Transition to a VAS

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Just as we need to eliminate subsidies for coal and other fossil fuels we need to eliminate subsidies for meat and dairy products and for animal feeds and instead subsidise plant based foods for direct human consumption and ecological restoration.

Global and European Agricultural Subsidies

The Lancet Commission Obesity Report outlines how "global subsidies in 2015 from governments to the fossil fuel industries were about $5.3 trillion each year (6.5% of global GDP) and nearly half a trillion dollars go to agricultural subsidies in the top 21 food-producing countries every year. Subsidies are predominantly for beef and dairy and a small number of grains, such as corn, wheat, and rice, that are used for animal feed or form the basis of most ultra-processed foods. The costs of the environmental damage from these industries, through greenhouse gas emissions, waterway degradation, and soil erosion, as well as the health costs from their products, will largely be paid by the taxpayers and ratepayers of current and future generations. The dynamics of the operating conditions for businesses, and corporations in particular, must be fundamentally transformed if we expect business to contribute to the solutions for health, obesity and Climate Change."

The Lancet calls for 'Big Food' to be treated like Big Tobacco, and says industry leaders should be barred from lobbying governments, as their interference is having a negative impact on people and the planet. The report recommends that Beef and Dairy subsidies should be scrapped and redirected to 'sustainable farming for healthful food'.

The Commission recommends that governments redirect these subsidies into more sustainable energy, agricultural, and food system practices. A Framework Convention on Food Systems would provide the global legal structure and direction for countries to act on improving their food systems so that they become engines for better health, environmental sustainability, greater equity, and ongoing prosperity.

EU Common Agriculture Policy

International trade and agricultural policies have played a key role in the growth of animal agriculture. The EU's trade policies and agricultural policies have ensured the availability of cheap feed, maintained prices of animal products competitive in the international market via export subsidies and import tariffs, and regulated the market through production quotas and buying excess agricultural products if prices are in danger of falling. A number of EU Common Agricultural Policy (CAP) reforms, to address market distortions, transformed subsidies into income support mechanisms. In the 1990s payments were still coupled to production, compensating farmers for lower market prices. After 2003, the majority of CAP funds (around 90%) became increasingly decoupled from production, linked only to the amount of land farmed. According to Commission figures, CAP subsidies reach nearly 7 million farms, covering 90% of total European farmland.

69% to 79% of EU CAP direct payments is for animal agriculture

According to a Greenpeace 2019 Report: "Between 69% (€28.5 billion) and 79% (€32.6 billion) of the CAP direct payments is directed to producers of fodder for animals, or goes directly to livestock producers as coupled support. That's between 18% and 20% of the EU's €157.86 billion budget in 2017. This estimate only includes CAP direct payments and excludes funds for the Rural Development Programme so the amount of total CAP funding supporting the livestock sector is higher than these figures."

Revision of the CAP

In June 2018 the European Commission presented its proposal for the CAP post 2021. The Commission claims that the new CAP proposal introduces a new plan for direct payments that is better targeted, fairer and greener. However, despite criticism by a wide range of stakeholders on direct payments, the proposed plan leaves them untouched. The EU budgetary watchdog, the Court of Auditors, recently highlighted that the CAP proposal "continues to impose on Member States the use of direct payments based on a given amount of hectares of land owned or used. This instrument is not appropriate for addressing many environmental and climate concerns, nor is it the most efficient way of supporting viable farm income." Greenpeace commented that: "The Commission proposal thereby provides EU governments with a blank cheque, allowing them to maintain unaltered the current CAP payments, benefiting the most powerful agricultural players and underpinning an unsustainable farming sector."

Payment for Ecosystem Services

Ecosystem services are the many and varied benefits that humans freely gain from the natural environment and from properly-functioning ecosystems. Such ecosystems include, for example, forests, grasslands, wetlands and aquatic ecosystems. Collectively, these benefits are becoming known as 'ecosystem services', and are often integral to the provisioning of clean drinking water, the decomposition of wastes, and the natural pollination of crops and other plants, etc.

Ecosystem services are often grouped into four broad categories (as shown in the diagram on the following page):

Provisioning, such as the production of food and water; *regulating*, such as the control of climate and disease; *supporting*, such as nutrient cycles and oxygen production; and *cultural*, such as spiritual and recreational benefits. To help inform decision-makers, many ecosystem services are being assigned economic values.

On April 2nd, 2019 Members of the European Parliament voted on a CAP post-2020 reform. This included a "**min 20% of direct payments, 30% of rural development budget for environmental actions.**"

In Ireland "Total Department of Agriculture, Food and the Marine spending was over €2.6 billion in 2017.....An estimated €1.81 billion was paid by the Department to 130,118 farmers in 2017." Assuming the small farms payments of €220 million in 2015 remained the same then large farms would have received

€1.58 billion.

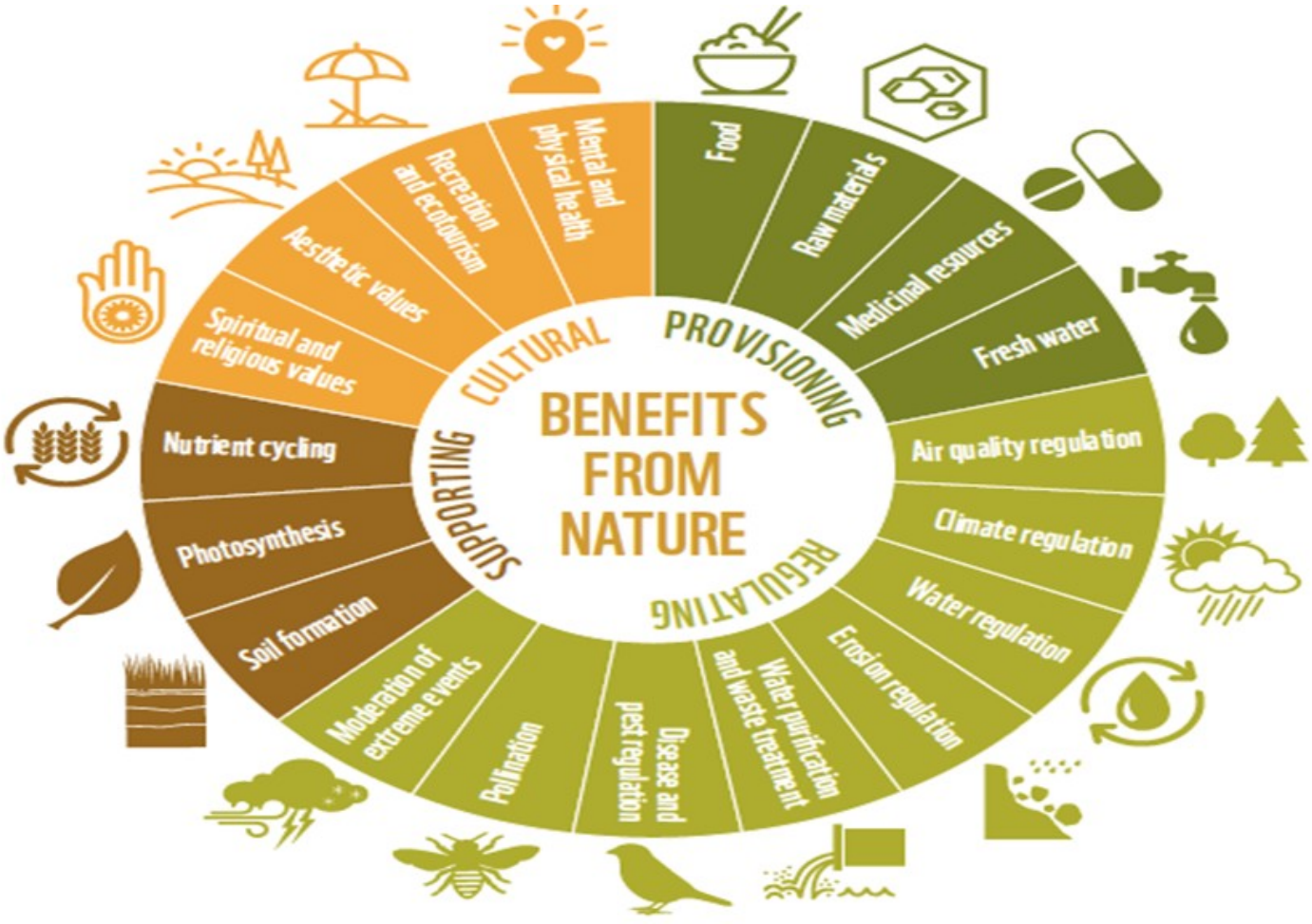
We propose that all the payments to small farm are for ecosystem service only and that the viable large farms are converted to plant based agriculture. Using the average farm type subsidy we estimate that current subsidies to large viable farms are as follows.

When we use the average subsidy figures and farm numbers from Teagasc the total does not add up to €1.8 billion. These figures are just an approximation.

Farm Type	Subsidy €	Viable Farms	**Viable Land ha**	Total Subsidy Million Euros
Dairy	€19,328	13,293	**744,416**	**€257**
Cattle Rearing	€14,242	4,190	**146,647**	**€60**
Cattle Other	€16,436	8,648	**319,976**	**€142**
Sheep	€19,145	3,572	**182,184**	**€68**
Tillage	€23,239	5,466	**327,983**	**€127**
		35,170	**1,721,207**	**€654**

Current subsidies to large sustainable and vulnerable farms are as follows.

Large Farm Type	Subsidy €	Sustainable &Vulnerable Farms	Sustainable &Vulnerable Land Area	Total Subsidy Million Euros
Dairy	€19,328	2,346	131,368	€45
CattleRearing	€14,242	15,762	551,673	€224
Cattle Other	€16,436	18,107	669,950	€298
Sheep	€19,145	9,313	474,980	€178
Tillage	€23,239	1,921	115,237	€45
		47,449	1,943,208	€790



WWF, Living Planet Full Report 2018

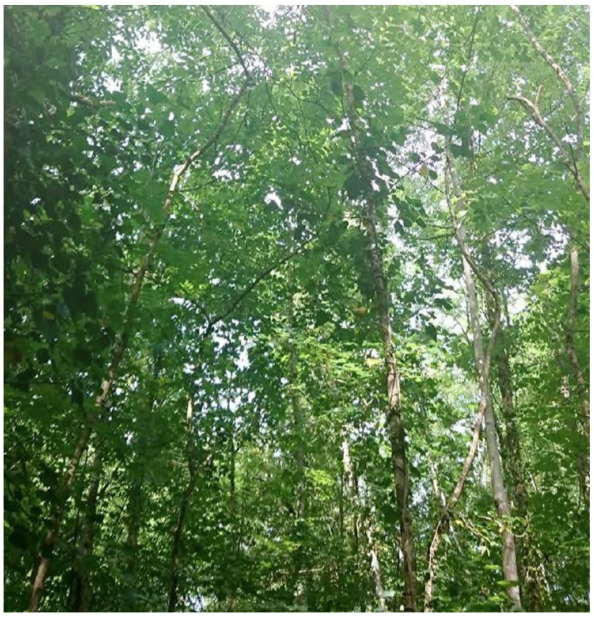
Ecosystem services are often grouped into four broad categories as shown in the above image.

If all the small farms and the sustainable and vulnerable large farms were converted to payments for ecosystem services this would amount to a total of €1 Billion (€790 plus €220) being allocated to payment for ecosystem services. €800 million in subsidies would be paid to the remaining farmers. We would recommend subsidies should not exceed a maximum of €50,000 per farm. Only 1.4% of Irish farmers get payments over €50,000 but they account for almost 10% of all such payments. This would allow the distribution of €180 million to smaller farmers.

Bramble–hazel woodland, Co. Cavan, Forest Service, Department of Agriculture.

10.1 Recommendations to Redirect Irish Agricultural Subsidies

1. We recommend that the approx. 55,000 large farms that are either sustainable or vulnerable large farms would transition to payments for ecosystem services. The remaining 37,720 large farms would focus on plant based food producion. This would reduce the agricultural land area for large farms from 4 Mha to 1.7 Mha, a reduction of 2.3 Mha.
2. If farmers can receive their current payments for Payment for Ecosystem Services then this can allow this transition to happen. On average this would actually increase the income of large beef and sheep farmers as follows (2018 figures).
   - Cattle rearing farmers from an average income of €8,318 to the subsidy of €13,109
   - Cattle Other farmers from an average income of €14,408 to the subsidy of €16,257
   - Sheep farmers from an average income of €13,769 to the subsidy of €18,812.
3. We would recommend that all small farms are converted from animal agriculture to payment for ecosystem services. This would see the conversion of 43,600 small farms to ecological enterprises. This could potentially increase the income of small land owners from approx. €3,000 to €5,500 and their time would be spent restoring the ecosystem services on their land. This would potentially free up 0.46 Mha of land for restoration of native forestry, grasslands and wetlands.
4. Overall total agricultural land use would be reduced from 4.5 Mha to 1.7 Mha, a reduction of 2.8 Mha.
5. A total of €1.07 Billion of subsidies would be allocated to payment for ecosystem services. €730 million in subsidies would be paid to the remaining 37,720 farmers – a subsidy of €19,350.
6. 1.7 Mha of this land would be converted to native forests and to reach the European average of 34% (2.5 Mha) forest cover. A further 1.1 Mha would be converted to native grasslands, meadows, and bog and wetlands. Some of the existing monoculture coniferous forests, if planted in inappropriate areas (impacting high-status water ecosystems), should be cleared at the end of their lifetime and not replanted.
7. While the income of sustainable and vulnerable farmers who transitioned to Payment for Ecosystem Services would stay the same or increase, viable farmers would need to generate income from plant based food, fibre and fuel crops. Appropriate subsidies and technical and training supports would be needed to ensure that income levels are maintained and enhanced.
8. We would recommend that no CAP payment should exceed €50,000 per farm. "Only 1.4% of Irish farmers get payments over €50,000 but they account for almost 10% of all such payments." This would allow the distribution of €180 million to smaller farmers. Very large profitable farms should not be subsidised.
9. In the future, payments may not be tied to land area but to ensuring that all rural landowners are getting a living wage for contributing to meeting the state's legal and ethical obligations to current and to future generations.



Forest Service, Department of Agriculture

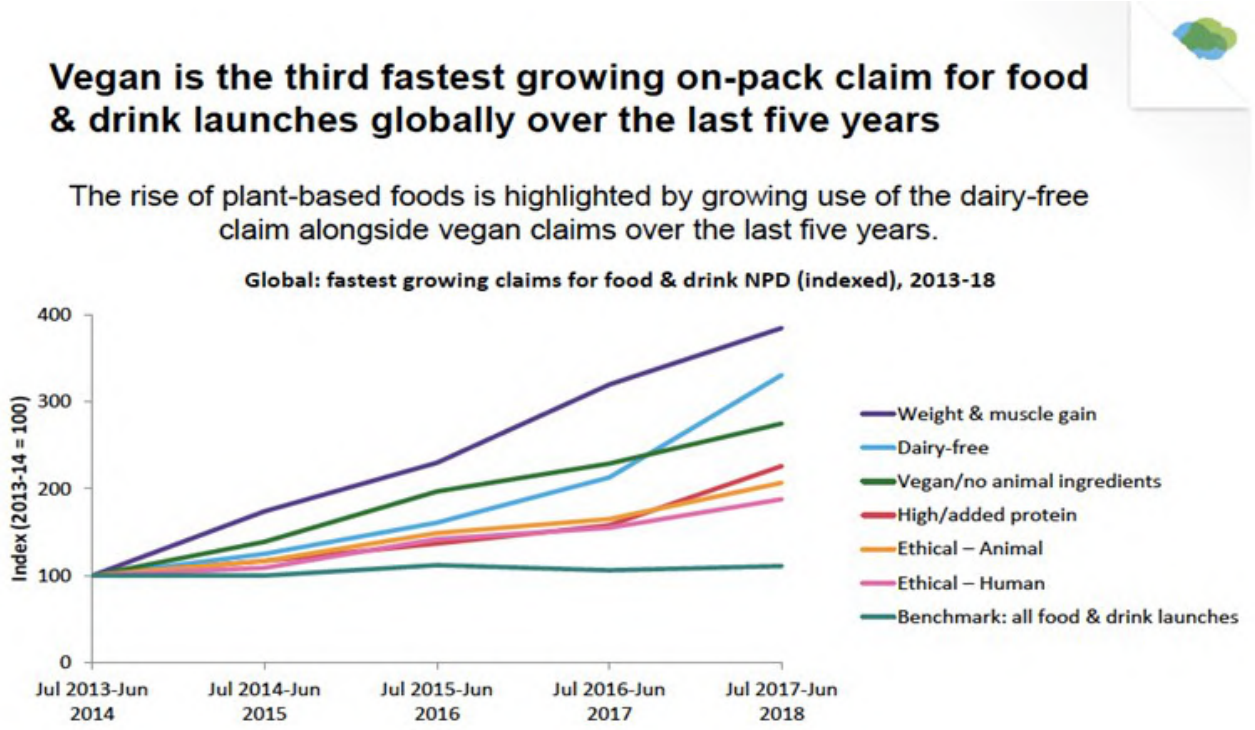
Chapter 11: The Future of Food

Chapter 11: The Future of Food

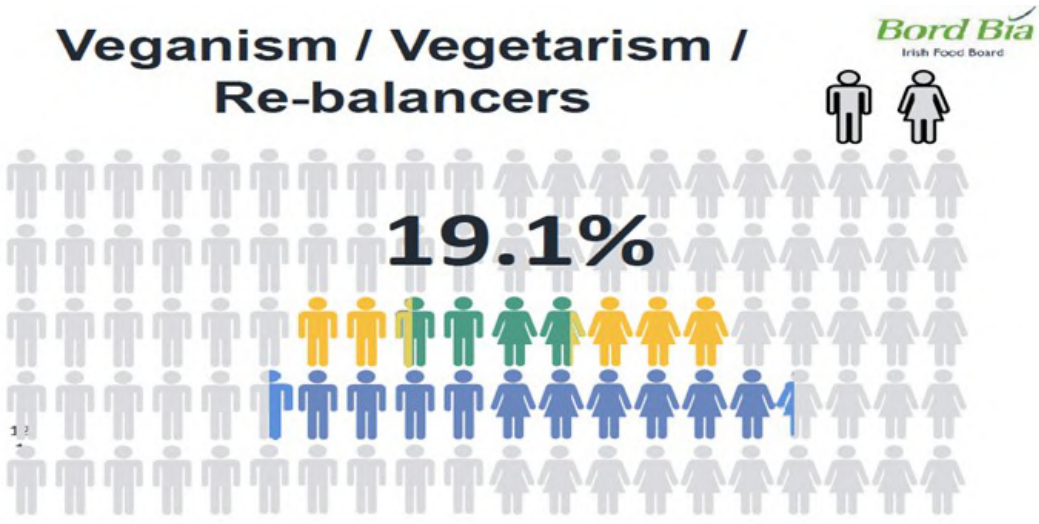
This chapter presents a number of initiatives and case studies that show how a sustainable vegan agricultural system is possible in Ireland and internationally. This change can drastically improve food security, enhance the economic security of farmers and reduce agricultural land use globally by 75%. This will create the physical space needed for biodiversity and ecosystems to gradually be restored which will stabilise the climate.

Transitioning to a vegan, socially just agricultural system

Around the world vegan consumers are driving a positive change to the food system. Food producers and retailers are happy to support this transition and are embracing this hugely positive business opportunity. An Irish Bord Bia 2019 Presentation highlighted that in the past five years Dairy Free and Vegan are the second and third most common global on-pack claim for new food and drink launches. Ethical branding is also growing significantly.



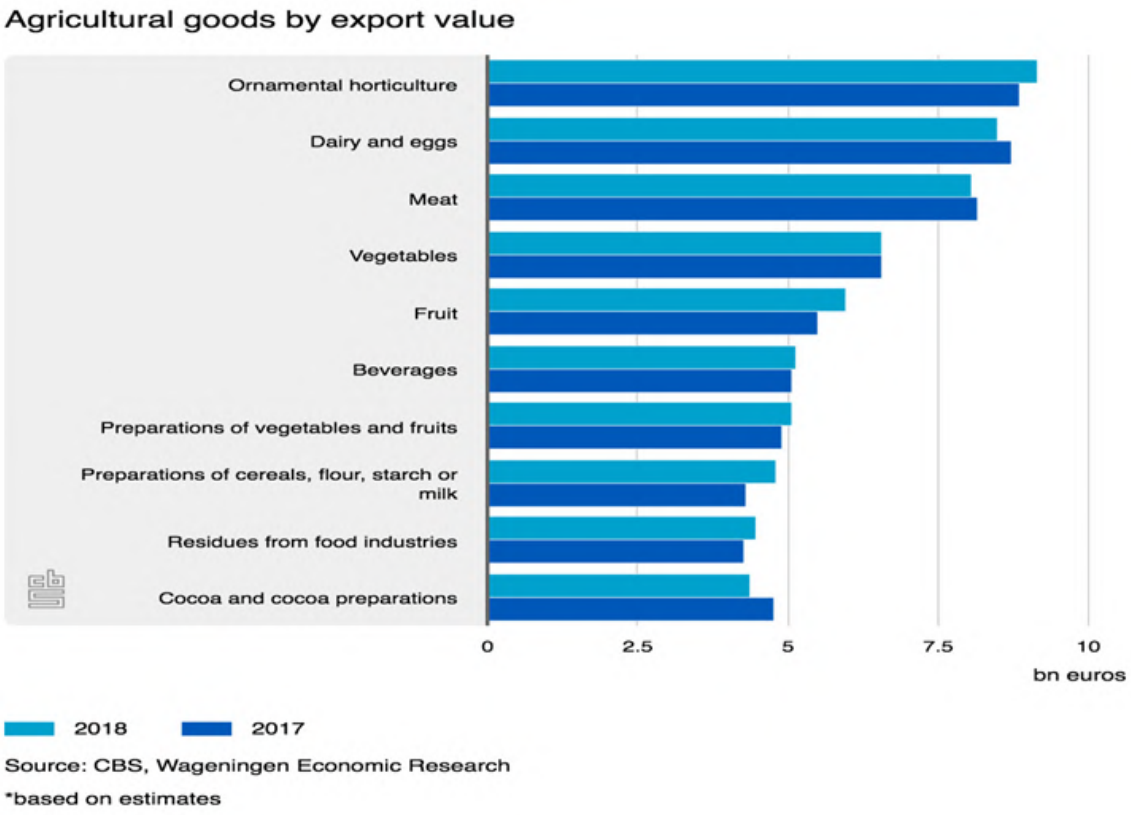
There are now plant-based alternatives to every type of food including meat, fish, dairy and egg products. The availability of plant-based alternatives and meat analogues is increasing in all the major supermarket chains and health and wholefood shops. More and more restaurants are also adding vegan options to their menus. This, along with increased knowledge about the ethical, environmental and health benefits of veganism through social media, is contributing to the growing vegan population. Veganism is now a growing movement in nearly every country in the world. Even meat companies like Tyson are investing in vegan products. The change is also happening in Ireland where (in 2018) there were over 600,000 Vegans, Vegetarians and people reducing meat as highlighted below.



11.1 Lessons from the Netherlands Agricultural Model

The Netherlands' agri-food exports are nearly seven times Ireland's agri-food exports on less than half (40%) of Ireland's agricultural land. After the US, the Netherlands is the world's largest exporter of agricultural goods with an export value in 2018 of €90.2 billion. In 2018 the Netherlands exported an additional €9.2 billion of goods related to agriculture, such as agricultural machinery, machinery for the food industry, greenhouse materials, fertiliser and plant protection products. The below image summarises some agri-food sector info for 2017.

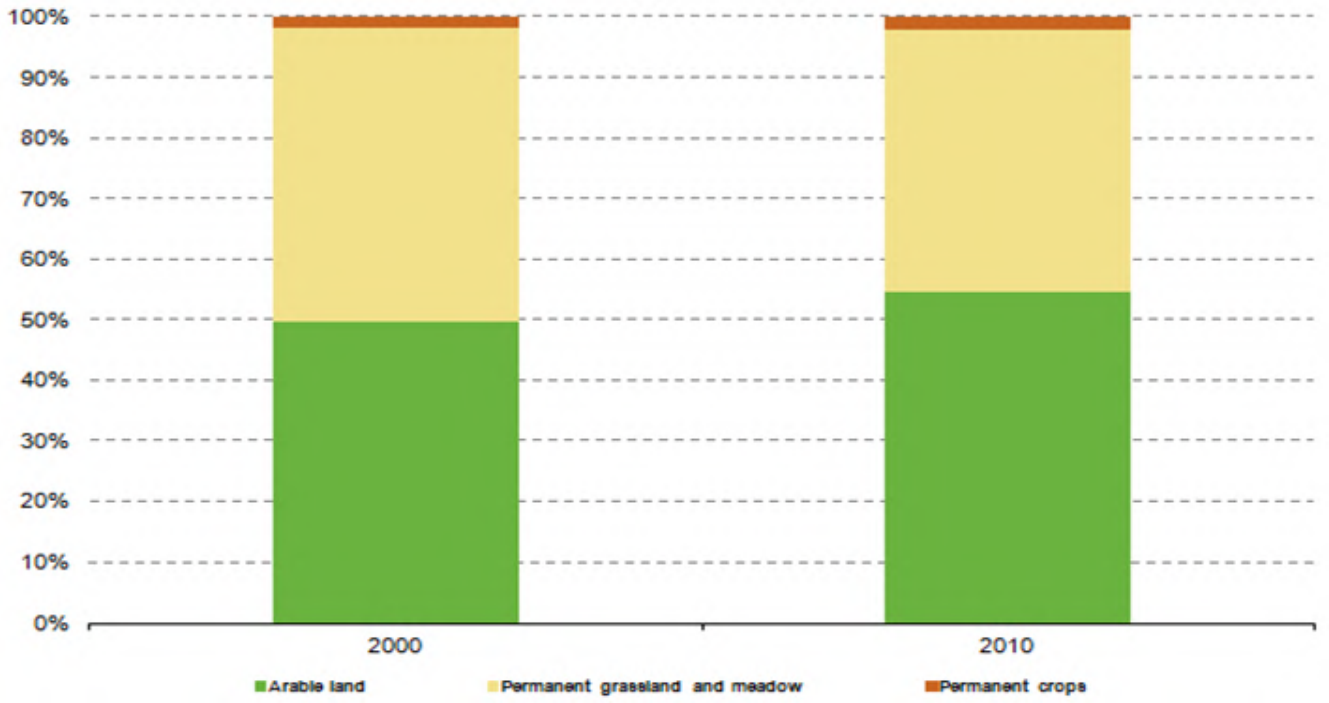
In 2018, the Netherlands imported an estimated €61.4 billion in agricultural goods. There was an agricultural trade surplus of €28.8 billion, slightly lower than in 2017. Agricultural trade represents almost 58% of the Netherlands' total trade surplus. Agricultural commodities account for nearly one-fifth of Dutch commodity exports: 18.2% in 2018. Domestic production makes up 72.4% of these agricultural exports. The below image shows that nearly 50% of the agricultural exports from the Netherlands are plant based.



60% of the land area of the Netherlands is used for plant based agriculture with large fruit, vegetable, and ornamental flower sectors as shown above. The below table compares the land use and the agri-food balance of trade in Ireland and the Netherlands.

Topic for Comparison	Netherlands	Ireland
Total Land Area	4.15 Mha	7.03 Mha
Arable land	1.03 Mha	0.38 Mha
Land under permanent crops	0.04 Mha	0.00 Mha
Land under perm. meadows and pastures	0.73 Mha	4.15 Mha
Forest Land Area	0.38 Mha	0.77 Mha
Total Agricultural Land Area (excl forest)	1.80 Mha	4.53 Mha
Agri-Food Exports	€90.2 Billion	€13.2 Billion
Agri-Food Imports	€61.4 Billion	€9 Billion
Agri-Food Trade Surplus	€28.9 Billion	€4.2 Billion

The area of agricultural land used for plant based farming in the Netherlands is gradually increasing as shown below. But although today 60% of agricultural land is used for plant based agriculture unfortunately a lot of land is still used to produce animal feed.



Graph of Changing Land Use in the Netherlands between 2000 and 2010

Five Lessons from the Netherlands Agri-Food Model

Since the 1950s farming in the Netherlands followed a model of increased intensification on larger farms with increasing inputs of fertilisers, pesticides and energy. This had a very negative impact on biodiversity, GHG emissions, air and water pollution, etc. According to the Netherlands Environment Protection Agency the main problems were biodiversity loss, "eutrophication, over-fertilisation, acidification, desiccation and fragmentation of the natural environment." The eutrophication was caused by "an oversupply of nutrients — such as nitrogen, phosphate, ammonia and sulphur dioxide from agriculture — being deposited in natural areas." Over the past twenty years the Netherlands has been moving in a more sustainable direction but it still has major environmental problems due to its high levels of meat and dairy production and also high levels of energy consumption and fertiliser use. But there are some valuable lessons that can be learned from this country's agricultural system.

1. **Reducing inputs of fertilisers and pesticides** while maintaining or increasing yields. According to a recent article, since 2000 "farmers have reduced dependence on water for key crops by as much as 90%. They've almost completely eliminated the use of chemical pesticides on plants in greenhouses." Fertilisers are delivered directly to crop roots.
2. The key to the Dutch financial success is a **long horticultural tradition** and decades of developing **high-level knowledge and techniques**. Dutch horticulture relies heavily on its 93 Km^2 of high tech greenhouses, allowing farmers to closely control growing conditions and use fewer resources like water and fertilizer. Twelve of the world's biggest agri-food companies host strategic R&D or production

facilities in the Netherlands, which is also home to Wageningen University and Research (WUR), the top agricultural university in the world.

3. **Seeds.** The development of genetically modified organisms to produce larger and more pest-resistant crops is a model being explored by companies like Monsanto and Bayer. Dutch firms are among the world leaders in the seed business, with close to $1.7 billion worth of exports in 2016. Yet they market no GMO products. A new seed variety in Europe's heavily regulated GMO arena can cost a hundred million dollars and require 12 to 14 years of research and development. By contrast, the latest achievements in the venerable science of molecular breeding—which introduces no foreign genes—can deliver remarkable gains in 5 to 10 years, with development costs as low as $100,000 and seldom more than a million dollars.
4. **Technology and Innovation.** A noticeable factor is the increasing demand for **Dutch agricultural materials, innovations and high-quality technology**. Exports in this area totalled nearly €9bn. Examples of such exports include **energy-efficient greenhouses, precision agriculture systems (via GPS and drones) and new discoveries that make crops more resistant to the effects of climate change and diseases.**
5. **Learning and Working in the Global South.** The Netherlands has extensive Agricultural Education and Overseas Development Projects.

This case study shows that plant based foods are highly profitable and are completely compatible with an export oriented agri-food sector like Ireland's. It also shows that the Irish Government will need to invest substantially in education and research, technology and infrastructure in order to support farmers' transition to a VAS.

11.2 Import Substitution

Ireland currently imports €4.3 - €5 Billion of plant based foods as shown in the below extract from the CSO Import / Export Table.

	Product Categories listing Plant Based Related Products		Exports € millions	Imports € millions
	4	Cereals and cereal preparations	416	1,096
	5	Vegetables and fruit	299	1,251
	6	Sugars, sugar preparations and honey	158	376
	7	Coffee, tea, cocoa, spices and manufactures thereof	365	591
	9	Miscellaneous edible products and preparations	2,500	713
	22	Oil seeds and oleaginous fruits	8	33
	41	Animal oils and fats	81	20
	42	Fixed vegetable fats and oils	11	223
	43	Animal or vegetable fats and oils, processed; waxes	1	20
		Total:	€3,839	€4,323
		Plant Based Products:	**€1,580**	**€4,351**
		Both Animal and Vegetable Products:	€2,640	€944

CSO Website

Many of these foods could be grown in Ireland. Currently we are importing potatoes, onions, cabbages, apples, pears, wheat, etc. as shown in the table on the following page. Greenhouses would enable the commercial production of some other crops that need more controlled conditions on a large scale that are currently not grown in Ireland. The Netherlands has 9,300 ha of high-tech greenhouses. While these require substantial energy inputs they can still provide ideal growing conditions for a range of more temperature sensitive crops. It might be possible that some of the buildings currently used for animal agriculture could be modified or replaced by greenhouses for crop production. Imported oils like palm and soybean oil could be replaced by oil seeds suitable for growing in Ireland like rape, flax, hemp, and perhaps sunflower. Funding would be needed to invest in the latest high-tech greenhouses not using hydroponic systems but making use of a healthy soil micro-biome. Some trade protection would be needed for Irish farmers to allow Irish markets to get established and become competitive. For example the Irish Sugar Beet Industry could replace imported sugar cane from tropical countries restarting a €300 Million industry. The below table lists a selection of Ireland's plant based crop imports in 2016 that could be grown directly in Ireland or substituted with a similar crop. Importing crops that can be easily grown in Ireland while exporting meat and dairy to distant countries is highly inefficient and environmentally unsustainable.

FAO Stat – Value of Crops Imported to Ireland in 2016 in USD			
Apples	$69,067,000	Oil, palm	$78,117,000
Artichokes	$548,000	Oil, rapeseed	$18,576,000
Asparagus	$3,619,000	Oil, soybean	$49,447,000
Beans, dry	$3,859,000	Oil, sunflower	$14,829,000
Beet pulp	$22,154,000	Oil, vegetable origin nes	$14,528,000
Bran, wheat	$30,837,000	Onions, dry	$28,765,000
Bread	$16,316,000	Pastry	$430,675,000
Cabbages and other brassicas	$10,202,000	Potatoes	$48,462,000
Carrots and turnips	$14,964,000	Potatoes, frozen	$90,924,000
Cauliflowers and broccoli	$16,573,000	Strawberries	$21,354,000
Cereals, breakfast	$156,978,000	Tomatoes	$50,727,000
Chillies and peppers, green	$37,392,000	Tomatoes, peeled	$22,251,000
Cucumbers and gherkins	$10,190,000	Vegetables in vinegar	$25,411,000
Flour, wheat	$83,252,000	Vegetables, fresh nes	$18,704,000
Fruit, prepared nes	$85,263,000	Vegetables, frozen	$45,131,000
Grapes	$35,473,000	Vegetables, preserved nes	$78,743,000
Lettuce and chicory	$27,140,000	Wheat	$45,054,000
Mixes and doughs	$51,514,000	Rape+Mustard Oils	$18,576,000
Nuts, prepared	$20,509,000	Rice	$27,910,000
Oil, olive, virgin	$20,515,000	Sugar and Honey	$402,414,000
		Grand Total:	$2.25 Billion

Source: FAO Stat

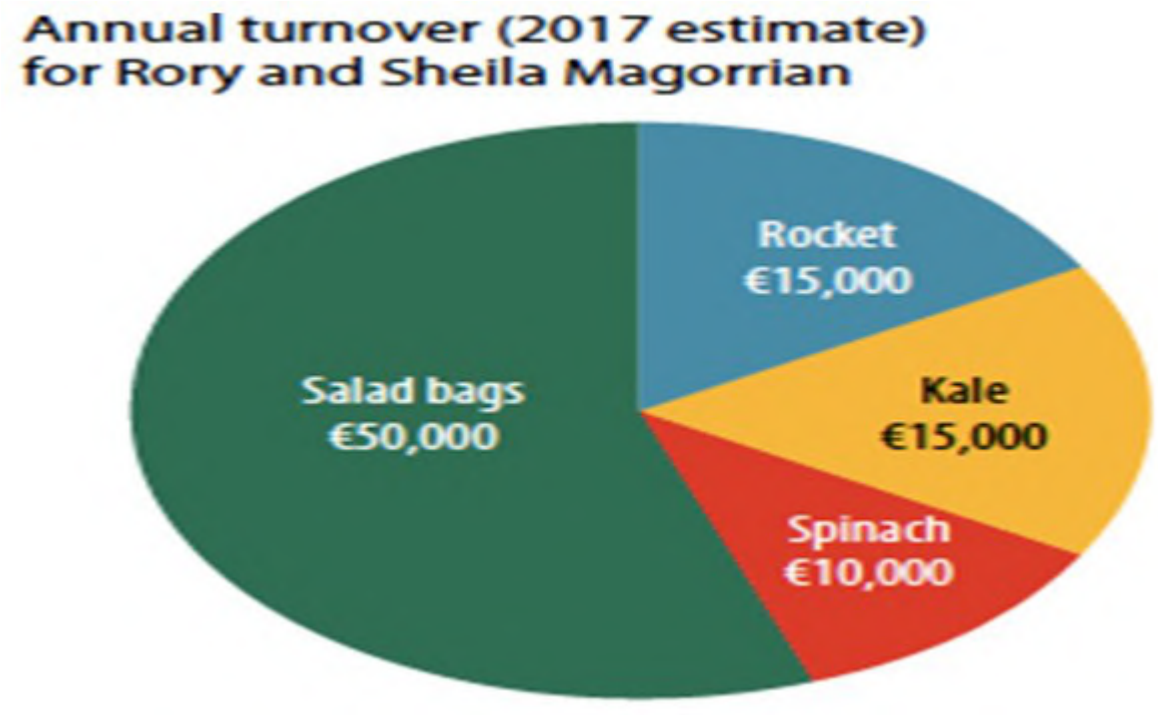
Case Study of Kildinan Farm, Cork

Rory and Sheila Magorrian, moved to north Cork in 2001 and purchased the 20 acre Kildinan farm in the rural hills surrounding the village of Ballyhooley. "We had a keen interest in growing vegetables and were keen to make the most out of the farm. I completed a horticulture course in Killaloe, Co Clare, and made the decision to convert part of our farm to organic production." The family produce a range of salad leaves on five acres of land and with labour provided by the couple they are able to make an adequate income.

Table of Crops Produced in Kildinan Farm

Crops	Acres
Field scale vegetables – kale and spinach	2.0 acres
Cloches (movable polythene tunnels): Four in summer – lettuce, rocket; Eight in winter – spinach, some lettuce	0.5 acres
Polytunnels (five) including one for plant propagation: salad/lettuce leaves, some domestic veg.	0.3 acres
Orchard – blueberries (new)	0.1 acres
Total salads/kale and spinach	2.9 acres
Green manure crops (to build soil fertility) Red clover, buckwheat, phacelia (mainly field scale)	2.1 acres
Total	5.0 acres

Turnover for the enterprise for 2017 will be approximately €90,000. "Income is relatively constant throughout the year," says Rory. "The main costs amount to €15,000 to €20,000 per year and include packaging, printing, labelling, diesel for deliveries, seed, compost, electricity and infrastructure upkeep."



Teagasc website

So if the income after costs was €70,000 on 2 hectares (5 acres) that's €35,000/ha. In comparison, the below table shows the income per hectare for animal agriculture in Ireland in 2018. The small plant based family farm produces a per hectare income that is 90-125 times the income for sheep and beef farms in Ireland and 33 times the average per hectare income of dairy farms and 50 times for Tillage farms.

	Size (ha)	Income per ha
Dairy	58	€1,049
Cattle Rearing	31	€269
Cattle Other	37	€387
Sheep	49	€281
Tillage	61	€697
All	43	€542

Preliminary NFS 2018 Average Farm Size & Income per ha, Teagasc 2019

Overall, what advice would Rory and Sheila give to anyone considering going into organic vegetable production on a small holding? Rory says: "The market is there but at the same time you have to work on it yourself. **I believe the model operating on our farm can be replicated around the country.**" This simple case study shows how a family farm can produce healthy plant based foods and generate an income that is close to the average industrial wage.

11.3 Protein Production and Use in European Agricultural Systems

Legumes or pulses are the cornerstone of plant based diets around the world and will be a key part of a vegan agricultural system, both because they fix nitrogen in the soil and provide a rich source of protein with high fibre and low saturated fat content. Legumes include beans, lentils, peas, peanuts, lupins, alfalfa, and clover. The term *pulse*, as used by the FAO, is reserved for legume crops harvested solely for the dry seed. This excludes green beans and green peas, which they classify as vegetable crops. The FAO classifies seeds that are mainly grown for oil extraction like soybeans and peanuts as oilseeds. They classify legumes that are used exclusively for forage like clovers and alfalfa as forage crops. The below extract is taken from a 2017 Report into Legume Production in the EU and what policy changes are needed to grow this industry. This report is still within the mind-set of animal agriculture but some of its recommendations would be beneficial for establishing a VAS.

"Grain legumes are currently under represented in EU agriculture and produced on only 1.5% of the arable land in Europe compared with **14.5% on a worldwide basis**. There are opportunities for greater use of legumes in new foods. Here we review the contribution of ecosystem services by grain legumes in EU agriculture starting with provisioning services in terms of food and feed and moving on to the contribution they make to both regulating and supporting services, which are in part due to the diversity which these crops bring to cropping systems. We explore the need to understand grain legume production on the time scale of a rotation rather than a cropping season in order to value and manage the agronomic challenges of weeds, pests, and diseases alongside the maintenance or improvement of soil structure, soil organic matter, and nutrient cycling. A review of policy interventions to support grain legumes reveals that until very recently these have failed to make a difference in Europe. We contrast the EU picture with the interventions that have allowed the development of grain legume production in both Canada and Australia. Whether farmers choose to grow more legumes will depend on market opportunities, the development of supply chains, and policy support as well as technical improvements of grain legume production such as breeding of new varieties and management development to improve yield stability. However, to really increase the production of grain legumes in Europe, the issues are far more wide ranging than agronomy or subsidy and require a fundamental rethinking of value chains to move grain legumes from being niche products to mainstream commodities."

In the EU CAP system under what's called 'Voluntary Coupled Support (VCS)', Member States may grant support to types of farming/specific sectors that are particularly important for economic/social/environmental reasons and undergo certain difficulties – including protein crops. Of EU member states, 24 out of 28 have VCS for protein crops. France is the largest, with €443/ha of support, while Ireland supports protein crops through a €3 million VCS introduced in 2015 with payments of €250 - €280/ha. In the UK, initiatives like the Blueprint for UK Pulses are helping farmers with various support services to establish this important sector.

Where do you get your Protein?

For consumers, pulses contribute to a healthy diet through their high protein content, with pulses recording around 8-20g of protein per 100g of product. This is roughly double the amount of protein in cereal crops. Despite this, cereal crops are still a key source of low fat, high fibre, nutrient rich protein. All the large herbivores get their protein from grass where, according to Teagasc, the quantity of protein in grass (dry matter) varies typically from 16-28% depending on the sward type, growth stage, fertiliser regime and time of the year.

He gets his protein from plants

The below table shows that once someone eats a diet with sufficient calories they will have sufficient protein and that in Ireland plant based foods produce 15-25 times more protein per hectare than beef.

Item	Yield/ha kg	KCal/ Kg	Million Cal/ha	Person fed/ ha/yr	Protein Kcal /Kg	Protein MCal /ha	Protein /person / ha/yr
Wheat – total	10,200	3,390	34.58	47	496	5.06	69
Oats – total	8,400	3,890	32.68	45	504	4.23	58
Barley – total	8,400	3,540	29.74	41	480	4.03	55
Beans and peas	6,600	3,470	22.90	31	840	5.54	76
Potatoes	44,900	770	34.57	47	80	3.59	49
Beef	260	2506	0.65	1	920	0.24	3

Yields from CSO for 2017and Protein and fat content from google and USDA.

Assuming a stocking density of 1.7 cattle per hectare raised for two years weighing 600 kg yielding 510 kg / ha /yr with 250 kg waste.
Assuming 4 Kcal per gram of protein and carbohydrates and 9 Kcal per gram of fat.
Assuming 2,000 kcal per person per day and 50g or 200 kcal of protein per person per day.

The below table shows that on 1.7 Mha of land you could provide enough calories for about 70 million people. This would provide the recommended daily protein allowance for 100 million.

Crop	Annual Yield Tonnes/Yr	Land Area hectares	Food Energy KCal/kg	Energy Yield T Kcal per Yr	Persons fed per Year	Protein g /Kg	No People Protein Needs met per year
Peas and Beans	3,300,000	500,000	3,470	11.45	15,686,301	210	37,972,603
Grains	3,360,000	400,000	3,390	11.39	15,603,288	120	22,093,151
Oil seeds	1,230,000	300,000	8,500	10.46	14,321,918	210	14,153,425
Potatoes	22,450,000	500,000	770	17.29	23,680,137	20	24,602,740
		1,700,000			69,291,644		98,821,918

11.4 Organic Farming can Feed the World

New scientific research has identified the important role that organic agriculture can play in feeding a global population of 9 billion sustainably by 2050. This section is an extract from an article by Peter Melchett of the UK Soil Association that delves into the data.

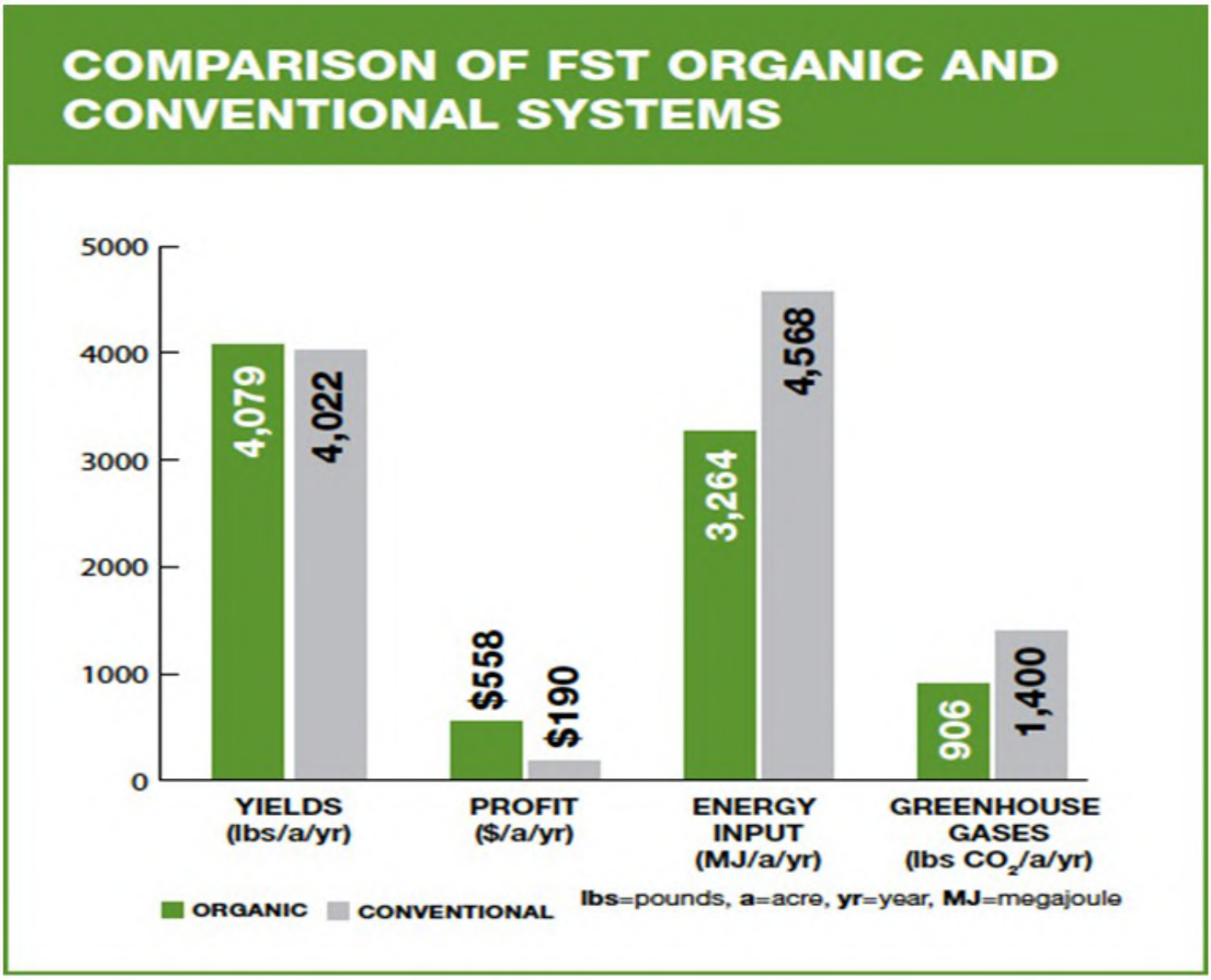
"High levels of meat and animal product in Western diets have a major impact on the environment and are causing a public health disaster. Published in the journal Nature Communications, by scientists from the Food and Agriculture Organisation (FAO) and the Research Institute of Organic Agriculture (FiBL), the key question the research examines is: "whether producing a certain total amount of food, in terms of protein and calories, with organic agriculture would lead to higher, or lower, impacts than producing the same amount of food with conventional agriculture". The scientists' answer is that organic agriculture can feed the world with lower environmental impacts – if we cut food waste and stop using so much cropland to feed farm animals. The authors conclude: "A 100% conversion to organic agriculture needs more land than conventional agriculture but reduces N-surplus and pesticide use."

However, they go on to explain that, "if food waste is reduced and arable land is not used to produce animal feed, with less production and consumption of animal products, 'land use under organic agriculture remains below' the current area of farmland." The authors note that organic agriculture has faced claims that far greater land use and associated deforestation would be necessary to feed the world organically due to a supposed yield gap of 20% on intensive production but this yield gap was found to be a myth as shown in the Thirty Year Farm System Trial by the Rodale Institute as highlighted below. "When other sensible and necessary changes are made, organic farming can provide enough food for healthy diets, and organic food is produced with far fewer unsustainable inputs." The improvements of a VAS go much further to build soils and protect water, while significantly reducing agricultural land use.

30 Year Farming Systems Trial by the Rodale Institute
The Farming Systems Trial (FST) at the Rodale Institute is America's longest running, side-by-side comparison of organic and chemical agriculture. Started in 1981 to study what happens during the transition from chemical to organic agriculture, the FST surprised a food community that still scoffed at organic practices. After an initial decline in yields during the first few years of transition, the organic system soon rebounded to match or surpass the conventional system. Over time, FST became a comparison between the long term potential of the two systems.

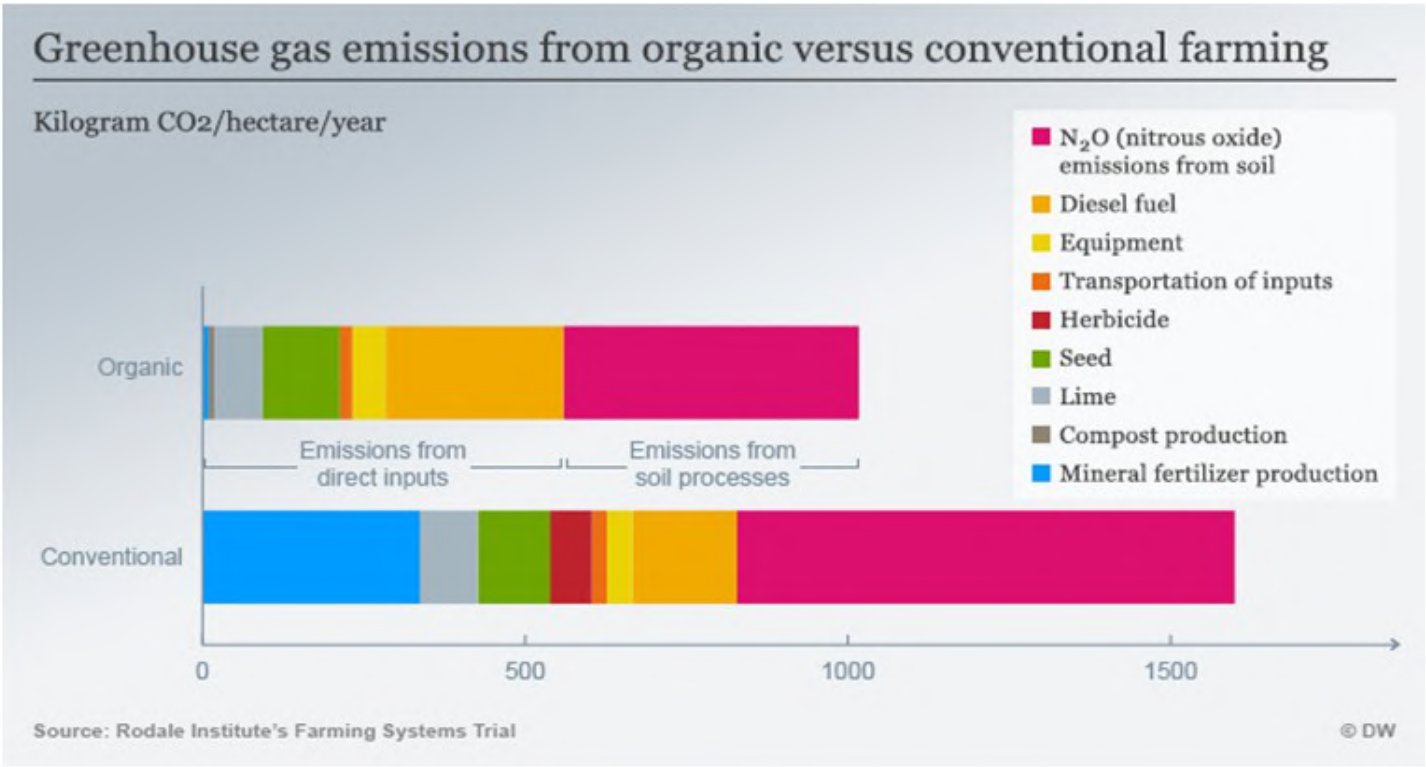
FST Findings

- Organic yields match conventional yields after a 5-year transition period.
- Organic outperforms conventional in years of drought by up to 40%.
- Organic farming systems build rather than deplete soil organic matter.
- Organic farming uses 45% less energy and is more efficient.
- Conventional systems produce 40% more greenhouse gases.



Rodale 30 year Farm System Trial

Organic agriculture has also been shown to produce less GHG emissions than conventional agriculture as shown below.



Rodale 30 year Farm System Trial

The Productivity of Vegan-Organic Farming

While the number of Certified Vegan Organic Farms is still very small, countries like India have a primarily vegetarian agricultural system. Plant based agriculture is already of critical importance in developing countries as it produces over thirty times more food calories per hectare. In 2018 The Humane Party produced a report comparing the productivity of a small-scale vegan-organic farm to conventional and organic agriculture outputs in the United States during the 2018 growing season. The following are the key findings.

- The vegan-organic farm was **2.3% more** productive than conventional and **41.6% more** productive than organic farming methods.
- The vegan-organic farm generated **868% more** income than conventional and **421% more** income than organic agriculture practices per kilogram of produce.
- The vegan-organic farm was 33.5% more productive than conventional and 85% more productive than organic farming methods when on-farm waste is considered.

So while much more research will emerge on certified vegan organic farms the initial results are promising.

11.5 Meat and Dairy Alternatives and Businesses

Good Food Institute Executive Director Bruce Friedrich pointed out: "We need to give consumers meat alternatives that cost the same or less, and that taste the same or better....Plant-based and cell-based meat gives consumers everything they love about meat - the taste, the texture, and so on - but with no need for antibiotics and with a fraction of the adverse impact on the climate." While acknowledging the huge investments accrued by plant-based tech startups like Impossible Foods and Beyond Meat, Friedrich says these industries are still nascent and substantial Government investment is needed to optimise and perfect the production of plant-based and cell-based meat. He comments, "We need the present meat industry. We need their economies of scale, their global supply chains, their marketing expertise, and their massive consumer base. We don't want to disrupt the meat industry; we want to transform it." The development of plant based meat and dairy products that taste like the real thing is continuing rapidly. Vegan companies have already produced and are marketing everything from plant based burgers and sushi to vegan cheese and chicken nuggets. In this section we just outline a couple of the initiatives in plant based alternatives.

Cultured Meat

Cultured meat is a plant-based product that has been created to have the look, taste and texture of meat. Research has suggested that the environmental impacts of cultured meat is significantly lower than normally reared and slaughtered beef. A study by researchers at Oxford and the University of Amsterdam found that cultured meat was "potentially much more efficient and environmentally-friendly, generating only 4% of GHG emissions, reducing the energy needs of meat generation by up to 45%, and requiring only 2% of the land that the global meat/livestock industry does". There are still ethical problems with cultured beef. However, research is being done in order to isolate cells which can be reproduced indefinitely in the lab, thereby removing the need to harm or use animals in the future. At Vegan Sustainability Magazine we think that whole food plant based proteins are a much healthier option than cultured meat, but we include this development to highlight the range of products being explored to replace meat and dairy products.

Milk grown in a lab

Milk grown in a lab is both humane and sustainable. In 2014 a synthetic dairy start-up called Muufri was founded by two bioengineers in California. Synthesising cow's milk is a relatively simple process. Milk has less than 20 components, and consists of about 87 percent water. The milk is made using the same process that pharmaceutical companies use to produce insulin. Although the proteins in Muufri milk come from yeast, the fats come from vegetables and are tweaked at the molecular level to mirror the structure and flavour of milk fats. While initially Muufri milk will be more expensive to buy than regular milk, eventually it will become cheaper as production is scaled up. The proteins made by Muufri yeast will be indistinguishable from natural ones, and the yeast itself is harmless.

Vegan Food Businesses

As we continue to transition to a vegan agricultural system there are already thousands of small and medium vegan businesses emerging. Here are two case studies highlighting two successful plant based companies in this emerging rapidly growing market.

The Vegetarian Butcher

This Case Study outlines the steps that Jaap Korteweg took to establish a Dutch meat analogues company. Jaap Korteweg decided to become a vegetarian in the late 1990s after he witnessed the swine fever epidemic that wiped out more than a million pigs in the Netherlands. He was a ninth-generation meat farmer and a real meat lover and founded The Vegetarian Butcher in 2007 to satiate his own need for quality 'meat' which was not produced from animals. Approximately seven years later, it has achieved turnovers of about 12 million euro, is profitable, enjoys annual sales growth rates of close to 50%, exports to 17 countries, and provides jobs to approximately 40 full-time employees. The company was taken over by Unilever in 2018. According to Korteweg, the acquisition has come at the right time. "We want to take the next step - conquer the world. It is our mission to make plant-based 'meat' the standard. We believe that with Unilever's international network, this acquisition will help to accelerate our mission."

Alpro

Alpro started out in Belgium in 1980 and today Alpro has 1,100 employees and in 2016 had a turnover of €522 million. According to the Alpro website plant-based alternatives to dairy are still only 4% of the European dairy market in terms of volume so there is plenty of room to grow. Alpro enjoys a 43% segment share in the plant-based milk category.

In Ireland the market for plant based milks continues to grow and sales of plant milks in Ireland jumped 40% from Jan. 2018 to Jan. 2019, while at the same time sales of cows milk dropped 3% mostly due to the Veganuary campaign.

11.6 Conclusion

Globally the world must solve two food problems simultaneously: end hunger and food insecurity and drastically reduce agriculture's damage to ecosystems and the ocean. The industrial food chain is dominated by meat production, which is hugely inefficient. According to a 2018 GRAIN Report, "Peasants are the main or sole food providers to more than 70% of the world's people and peasants produce this food with less (often much less) than

25% of the resources – including land, water and fossil fuels – used to get all of the world's food to the table. The Industrial Food Chain uses at least 75% of the world's agricultural resources and is a major source of GHG emissions, but provides food to less than 30% of the world's people." The myth of sustainable intensification and the industrialisation of agriculture needs to end. A transition to an ethical vegan family-farm agro-ecological model can result in sufficient economic and food security, an influx of younger farmers, and a slowing of rural-urban migration. It is essential that direct connections are re-established between farmers and consumers. Currently farmers in Ireland often get only 10 – 15% of the final sale price of the product that they have produced. On average 40% goes to food processors and a further 40% goes to the retailers.

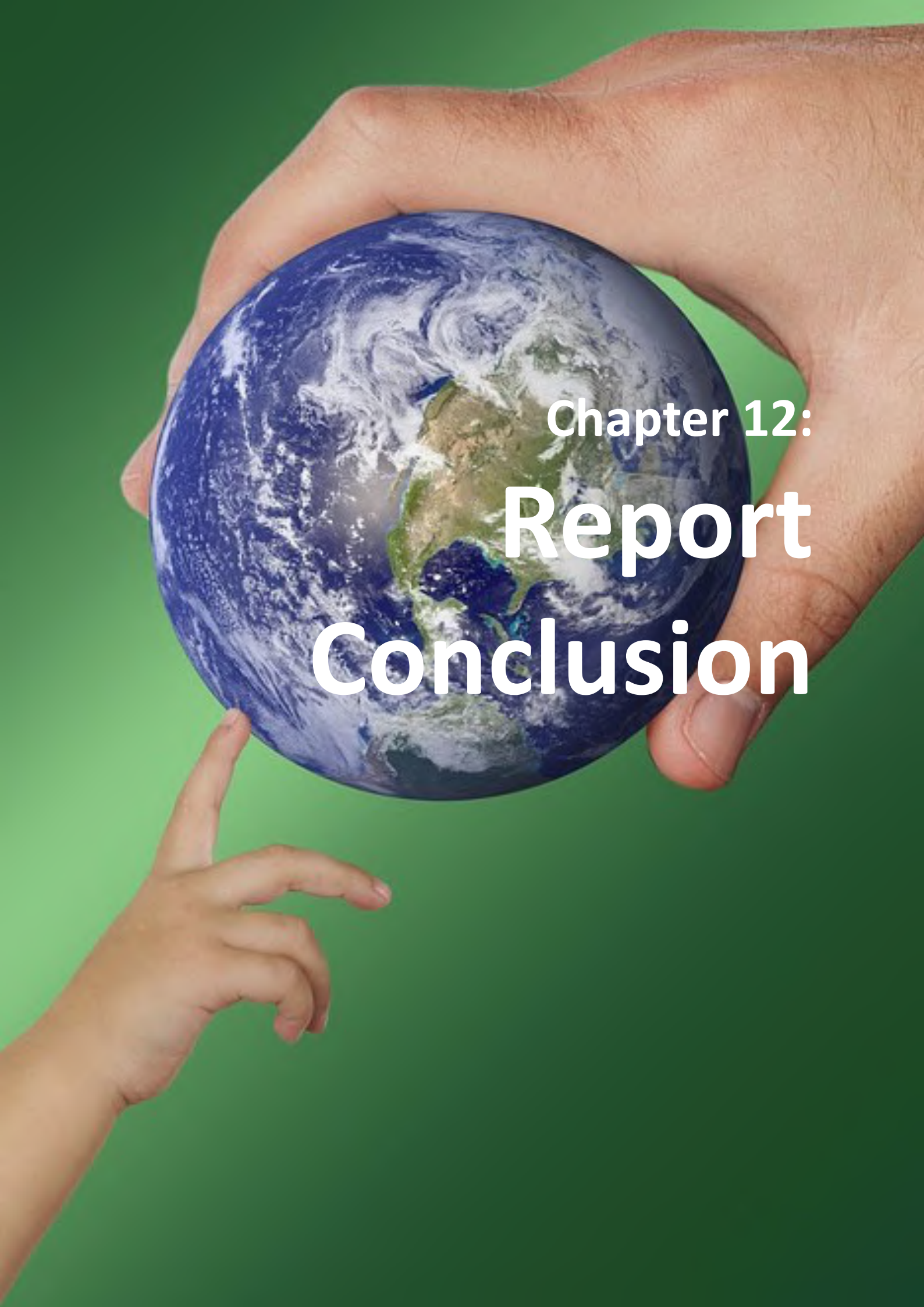
The most effective way for agriculture to change will come from changes in consumer behaviour supported by legal and policy supports for plant based agriculture from national governments and Global Agreements. In Europe and Ireland the CAP needs to change to stop subsidising meat and dairy production and instead support ecosystem services or plant based agricultural systems. A transition to a vegan agricultural system will enable us to:

- stop agriculture from consuming more forests;
- eliminate pesticides and antibiotics from agriculture;
- gradually restore ecosystems and biodiversity;
- boost the productivity of farms as plant based agriculture is much more efficient;
- raise the efficiency of water and fertilizer use worldwide;
- reduce waste in food production and distribution as grains and legumes are much easier to store without deterioration.

Globally switching to a whole food plant based diet has the potential to return millions of acres of land to wild habitat, to reverse rainforest destruction, to restore the health and volume of our freshwater rivers and lakes, to prevent further species extinctions, to eliminate billions of tons of pollutants (cow dung, carbon dioxide, methane, nitrous oxides, and ammonia), and to make a major contribution to stabilising and reversing climate change. Gradually as people become conscious of the ethical, environmental, economic, and health benefits then they will find the motivation to choose a plant based diet. When this happens is up to all of us. The faster it happens the faster we can stem the haemorrhage of biodiversity loss and restore our health and the health of the planetary systems we are dependent on.

If the transformations we are living through now teach us anything, it is that humans are capable of altering almost everything about our eating in a single generation.

Bee Wilson, The Way We Eat Now

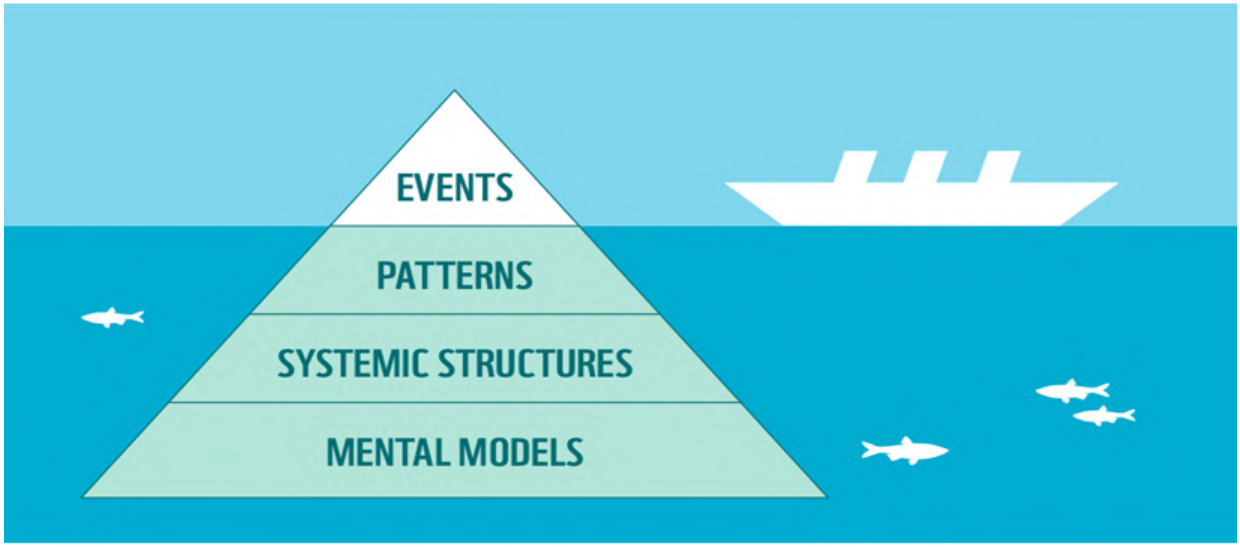


Chapter 12:
Report Conclusion

Chapter 12: Report Conclusion

"You never change things by fighting the existing reality. To change something, build a new model that makes the existing model obsolete." Buckminster Fuller

System Change
The food system is changing rapidly responding to many different drivers at different levels. One model for system change presented by the WWF is shown below.



WWF Living Planet Report 2016

Events include things that happen and can be measured like 70-100 billion animals being killed each year, rates of heart disease, antibiotic use, etc.

Patterns describe the cause and effect relationships between these events and their usually most obvious causes. Increasing efficiency of meat production has led to a huge increase in the number of animals being killed, this has doubled global per capita meat consumption with a corresponding increase in chronic illnesses.

Systemic structures are the legal, financial, technological, etc. systems that support our current way of producing food. These range from things like subsidies for meat and dairy production but not for fruit and vegetables to technological advances like the development of refrigeration to the development of antibiotics. They include the legal system that enforces the laws that reflect the dominant mental models of a society or at least the mental models of those who hold formal power.

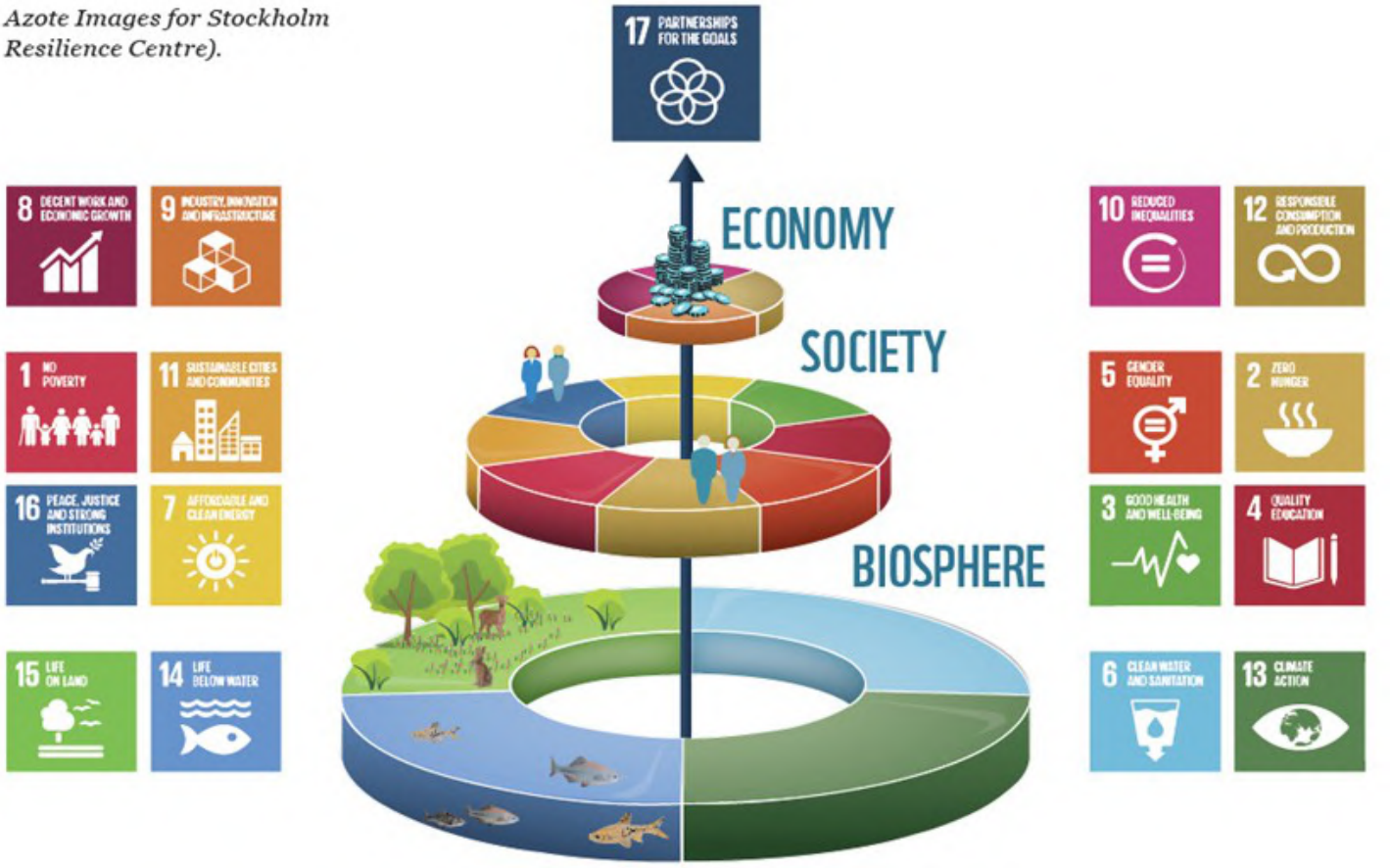
What really drives events, patterns and systems are the dominant mental models. These are the dominant belief systems, how we see the world around us, our values and our ethics. For example the belief that other species are resources or stock that can be used without ethical considerations is a key underlying belief. Changing our beliefs is the key to changing our systems, patterns and finally the happenings of our food system.

Ethics and the Law
An Internationally binding Declaration of the Rights of Other Species needs to be passed that enshrines the rights of other species to live free from harm and violence. This would provide the ethical underpinning for a VAS. At times the legal system has been progressive and has led positive changes and at times it resists changing to be in line with rational ethical understanding. A recent judgement in India is indicative of the laws starting to be passed locally as our legal system comes in line with the ethical scientific reality that other species are sentient beings and have rights. The ruling, by Punjab and Haryana State High Courts has granted 'legal person or entity' status to animals. This means that animals in the state of Haryana will be accorded the 'corresponding rights, duties and liabilities of a living person'. It follows a 2018 landmark ruling by the Uttarakhand High Court which said animals have 'distinct personas with corresponding rights, duties, and liabilities of a living person.' "The animals should be healthy, comfortable, well nourished, safe, able to express innate behavior without pain, fear and distress. They are entitled to justice. The animals cannot be treated as objects or property." The judgments need to be ratified by India's national Supreme Court. Eventually laws will be passed that make it illegal to kill other animals.

Systemic Structures - Subsidies
In developing countries the ending of subsidies for animal agriculture will play an important role in the transition to a VAS. Globally Payments for Ecosystem Services will also be key.

The Living Planet
If we save the living environment, the biodiversity that we have left today, then we will also automatically save the physical environment. If we only save the physical environment, then we will ultimately lose both. — E. O. Wilson

Azote Images for Stockholm Resilience Centre).



WWF Living Planet Report 2018

Human Society is dependent on the biosphere in ways we are just beginning to understand. Ecosystems and all living organisms are one integrated interdependent system as represented by the above diagram. The food system is one sub-system of society and the economy.

Globally the world must solve two food problems simultaneously: end hunger and food insecurity and drastically reduce agriculture's damage to ecosystems and the ocean. The industrial food chain is dominated by meat production, which is hugely inefficient. According to a 2018 GRAIN Report, "Peasants are the main or sole food providers to more than 70% of the world's people and peasants produce this food with less (often much less) than 25% of the resources – including land, water and fossil fuels – used to get all of the world's food to the table. The Industrial Food Chain uses at least 75% of the world's agricultural resources and is a major source of GHG emissions, but provides food to less than 30% of the world's people." The myth of sustainable intensification and the industrialisation of agriculture needs to end. A transition to an ethical vegan family-farm agro-ecological model can result in sufficient economic and food security, an influx of younger farmers, and a slowing of rural-urban migration. It is essential that direct connections are re-established between farmers and consumers. Currently farmers in Ireland often get only 10 – 15% of the final sale price of the product that they have produced. On average 40% goes to food processors and a further 40% goes to the retailers.

The most effective way for agriculture to change will come from changes in consumer behaviour supported by legal and policy supports for plant based agriculture from national governments and Global Agreements. In Europe and Ireland the CAP needs to change to stop subsidising meat and dairy production and instead support ecosystem services or plant based agricultural systems. A transition to a vegan agricultural system will enable us to:

- stop agriculture from consuming more forests, grasslands and other ecosystems;
- eliminate pesticides and antibiotics from agriculture;
- gradually restore ecosystems and biodiversity and thereby reverse climate change;
- boost the productivity of farms as plant based agriculture is much more efficient;
- raise the efficiency of water and fertilizer use worldwide;
- reduce waste in food production and distribution as grains and legumes are much easier to store without deterioration.

Globally switching to a whole food plant based diet has the potential to return millions of acres of land to wild habitat, to reverse rainforest destruction, to restore the health and volume of our freshwater rivers and lakes, to prevent further species extinctions, to eliminate billions of tons of pollutants (cow dung, carbon dioxide, methane, nitrous oxides, and ammonia), and to make a major contribution to stabilising and reversing climate change. Gradually as people become conscious of the ethical, environmental, economic, and health benefits then they will find the motivation to choose a plant based diet. When this happens is up to all of us. The faster we transition to a non-violent VAS the faster we can stem the haemorrhage of biodiversity loss and restore our health and the health of the planetary systems we depend on.

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Can Ireland feed itself? Yes. A nutritious diet? Not at the moment

Ruth Hegarty

Opinion: our intense focus on beef and dairy has given us advantage in global markets, but war in Ukraine has exposed our vulnerability in fruit, vegetable and cereal production. Ruth Hegarty, director of Egg&Chicken consulting, advocates for a more diverse agricultural economy.

Russia's invasion of Ukraine, known as the "bread basket of Europe", has far-reaching implications for food. The most direct and urgent implication is Ukrainians in besieged areas being cut off from food supplies, and the millions of people trying to flee Ukraine not being able to access food and water. This is where the immediate humanitarian focus needs to be. Beyond these immediate needs, there is great concern about the catastrophic impacts on Ukraine's agricultural production and the spill-over effects globally.

Ukraine is one of the world's major grain exporters. Seeds that were destined for Ukrainian fields sit in warehouses unable to reach farmers and the window to sow them is shortening by the day. Crops already in fields will not be harvested as long as Ukraine is under attack, and some crops may already have been destroyed.

The loss of Ukraine's exports of major agricultural commodities such as wheat, maize, and sunflower oil, along with the loss of fertiliser supplies from Russia, has serious repercussions for global agriculture and food supplies. In addition, there is growing concern for food security of North African and Middle Eastern countries that will feel the impacts most acutely, due to reliance on Ukraine and Russia for over half of their cereal imports and on wheat as their main staple.

Ireland has specialised in beef and dairy because of our strong competitive advantage in grass-based production. photograph: Alan Betson

But, as a country that produces and exports many times the food required to feed our population, do we need to worry about Ireland's food security? Why did the Minister for Agriculture ask this week that all Irish farmers grow crops this year? What does this say about Ireland's current food system and our food policies?

While Ireland is very successful at producing food and at finding exports markets for it, our agriculture has become highly specialised. We have focused primarily on beef and dairy production due to the suitability of our climate and our competitive advantage in grass-based production. Ireland is not unusual in this level of specialisation.

This has come about through increasingly globalised markets and policies that have encouraged countries to specialise in areas of production that they can do best and most efficiently; the very same reason why Ukraine is focused on production of wheat, other cereals, and oil seed crops, due to its rich, fertile plains. But, in order to produce the quantities of meat and dairy that we do, even in grass-based systems, we rely heavily on imported inputs of fertiliser and feed.

Because we have been so focused on beef and dairy, and because we have been able to source animal feed cheaply from abroad, we have not worried so much about growing other things.

A field of wheat in Co. Monaghan. Photograph: James Forde

"*Ireland is well placed to be food secure," says Fintan Keenan, a tillage farmer originally from Co Monaghan who has been farming wheat and beans organically in Denmark for the past 10 years. But as cheap wheat became abundant on global markets, Irish farmers were encouraged to stop growing it."* The same can be said for other crops and cereals, with the tillage sector seeing steady decline in recent decades due to challenges of viability.

'They will look at how many acres they can sacrifice to grow their own fodder... input prices will force them to think differently'

Now, having largely moved away from mixed farming systems and with many having left tillage, farmers are suddenly being asked to plant crops again. Will Irish farmers answer this call? Keenan believes they will, if they can. "*Farmers are rolling up their sleeves, they are responding because they are looking at the rising price of animal feed. They will look at how many acres they can sacrifice to grow their own fodder. These are farmers who would not dream of growing anything tillage-wise, but input prices will force them to think differently."* But that does not mean it will be straightforward.

"*The infrastructure simply isn't there. In Denmark, tillage is very much part of a mixed farming set-up and the facilities for drying, storage and milling are there in every community. Irish farmers aren't set up for this. Even if the equipment was there, the knowledge and skills have been lost."*

Keenan says Ireland is in a "double jeopardy" situation when it comes to staple crops such as wheat. We rely both on imported or homegrown wheat for animal feed and on wheat from international markets, mainly coming through the UK and France for milling, for flour.

Fintan and Turlough Keenan are brothers, farmers, entrepreneurs and wheat specialists. Photograph: Claire-Jeanne Nash

"*My sense is that any additional crops that will be grown this year by Irish farmers will be destined for animal feed, not for human consumption,"* says Keenan. That the main concern around shortages, and the call to grow crops, is focused on animal feed and not food for people seems clear. In a statement this week, the IFA suggested that potato farmers might be well placed to switch to tillage crops, indicating that human food production might be sacrificed for animal feed. Of course, in the short-term, the animals we have will need to be fed, but this exposes real weakness in Ireland's narrow approach to food policy.

"How can we be called food secure?" asks Fergal Anderson, a Galway-based farmer who produces vegetables and fruit for the local market with his partner Emanuela Russo. "*We export huge quantities of beef and dairy that are dependent on inputs. But humans don't live on steaks and milk. It is a huge simplification to say we are food secure; we don't produce the whole picture, right now we can't supply our own population with a nutritious diet."*

Indeed, specialisation also has consequences for what we produce. With policy support focused elsewhere, sectors such as horticulture have been left to languish. There has been a continual reduction in the number of fresh produce growers in Ireland over the past two decades and this exodus continues.

According to the IFA, the number of field growers of vegetables has fallen from an estimated 400 down to 100 in the past 20 years, and they attribute this exodus primarily to the ever-lower prices offered by retailers. Appeals to retail multiples to end the notorious 49c fruit and vegetable deals have so far fallen on deaf ears. Supermarkets serve their customers, and they want to offer them low prices.

Domestic horticulture is not given adequate support and no concerted policy effort has been made to prevent below-cost selling of fruit and vegetables.

Galway-based farmers Fergal Anderson and Emanuela Russo, who supply the local market with fruit and vegetables. Photograph: Reg Gordon

Ireland now finds itself importing the majority of our fruit and vegetables. While we will probably always want to import bananas and oranges, we also import vast quantities of crops that can be grown in Ireland, including tens of thousands of tonnes of apples, potatoes, onions, cabbages and carrots. Our reliance on imports of fruit and vegetables is something we have walked into with our eyes wide open in policy terms. Domestic horticulture is not given adequate support and no concerted policy effort has been made to prevent below-cost selling of fruit and vegetables.

"*Our focus on commodity production and exports has left local markets behind, particularly for fruit, vegetables and grains,"* says Anderson, "*We have been supplying local markets from our farm for 10 years, farming agro-ecologically, and we have never received government supports".*

The war in Ukraine, and its impacts on the global food system, are shining a light on problems that were already there. Anderson along with other small and medium-scale farmers, established ***Talamh Beo*** in 2019 to advocate for a new approach to farm policy in Ireland.

"*We are extremely exposed. The future we want is many eggs in many baskets. Currently Ireland has all its eggs in the dairy and beef baskets; and this makes things fragile because of all the inputs required and the fact that those inputs are mostly imported. There doesn't seem to be much interest in moving away from this currently,"* says Anderson.

But we know that we need to move away from it. We are in the midst of dual biodiversity and climate crises and the way we farm and produce food are key to solving them. The need to shift away from chemical inputs of fertilisers and pesticides, to reduce animal agriculture with its high reliance on imported feeds,

and to close the loop through regenerative agricultural practices has been clearly recognised at an international level and has been incorporated into EU policy through the Green Deal and the Farm2Fork strategy, but Irish policy has been slow to move in that direction.

The price of fuel, fertiliser and animal feed was already on the rise before Russia's invasion of Ukraine, and now with prices soaring and real concerns about supplies, there are serious implications for farm profitability. If the growing evidence of the huge environmental impact of our current farm practices has not been enough of a wake-up call, perhaps this will motivate the move to a new direction.

But farming organisations and agri-business representatives are already lobbying for relaxation of environmental measures in light of the Ukraine war and food security concerns. There is a real and palpable fear now among environmental groups and farmers who have advocated for a more regenerative, agro-ecological approach, that hard won-policy progress will be rowed back on.

Wheat farmer Mark Gillanders from Monaghan mills his produce for the Irish market. There aren't many farmers like him. Photograph: Philip Fitzpatrick.

Fergal Anderson represented the European Co-ordination **Via Campesina**, a farmer-led international organisation advocating for food sovereignty, at this week's European Commission meeting on Food Security and Contingency planning. He says that while there are genuine concerns about food security, the current crisis further highlights the fragility of current agricultural models. He says the Irish Government and the EU must avoid knee-jerk reactions and remain focused on long-term goals to move away from dependence on synthetic fossil fuel-based fertilisers and towards agro-ecology.

The vision of **Talamh** Beo, and **Via Campesina**, of which it is a part, is one of food sovereignty and agro-ecology, and this is what Anderson wants to see Irish policy move towards.

"The key difference between food security and food sovereignty is that food sovereignty includes agency of people and farmers in the process. It is about democratisation of the food system, one that doesn't centre on agribusiness and industry but on citizens and communities, that puts people and the environment first. It is inseparable from agro-ecology, which is an entirely different way of farming that doesn't depend on synthetic inputs, but on complementary livestock and crop production, closed nutrient cycles and biodiverse landscapes."

'If we want real sustainability, we should be building regional food economies, not motorways'

Fintan Keenan believes in moving Ireland in a similar direction. "*We are not talking about going back to horses and carts,"* he says, "*If we want real sustainability, we should be building regional food economies, not motorways. That means providing the supports and the environment for every region to produce grains, vegetables, meat and dairy."*

Both Keenan and Anderson point to further key challenges in both food and farming beyond our reliance on imports and our lack of diversity in production, not least declining farm incomes and the ageing farming population. Both believe things can be turned around, and farmers can deliver on the vision for a better food system, if the incentives are right.

"*We are really challenged by the culture from the top. We need policy shifts, but we also need a cheque through the door. A lot of farmers are doing what they are doing because that is what they have been taught by the State and industry for a long time. It is not easy to jump out of that loop. But I think, given the issues we are facing with input costs, more farmers will start to consider organics and alternative approaches now,"* says Keenan.

Anderson also believes the time is ripe for change. "*We need to create an enabling environment. If it costs money to produce fruit and vegetables here, we need to pay it; but we also need to put policies in place that ensure access to healthy and affordable food for all, not just those for who can pay more."*

"*It can be done. There are examples all over the world, including in Ireland, of regenerative systems that produce nutritious food for local communities. This is what needs support, not agrochemicals and fertiliser,"* says Anderson.

"*There is a shocking lack of vision in Ireland. But we have to ask ourselves what kind of agricultural sector do we want to have in five to 10 years' time? What does the Irish citizen want to see? More environmental damage, more concentration, more specialisation? Or vibrant local economies, that provide decent livelihoods to farmers and nutritious food to citizens."*

Ruth Hegarty is the director of Egg&Chicken Consulting, an agency dedicated to food policy, advocacy and education, and to developing diverse sustainable food businesses.

https://www.irishtimes.com/life-and-style/food-and-drink/can-ireland-feed-itself-yes-a-nutritious-diet-not-at-the-moment